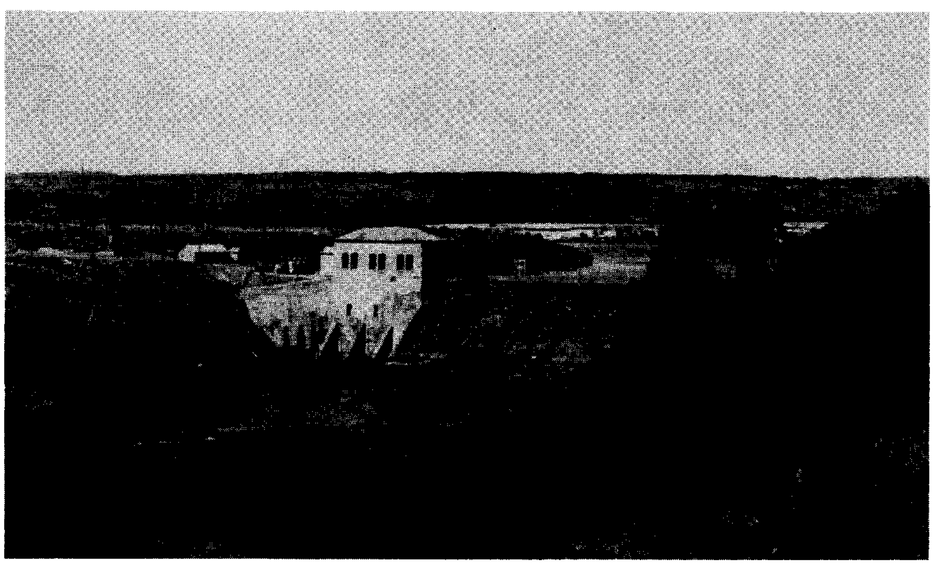
Volume 069 Article 07

FISHERY RESEARCH

ASHTON RESERVOIR FISHERY

ENHANCEMENT EVALUATION

Job Completion Report



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August 1987

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JOB COMPLETION REPORT

State of: Idaho

Title: Ashton Reservoir Fishery Enhancement Evaluation

Period Covered: April 15, 1985 to April 15, 1987

ABSTRACT

Ashton Reservoir, Idaho, supported low zooplankton densities due to the short retention time of 1.6 to 4.5 days. Low plankton densities probably contributed to the low overwinter survival rate of <1% for fingerling and catchable-size hatchery trout. High inflow to the reservoir kept the water column mixed and no summer stratification or winter inverse stratification was observed. Temperature and oxygen levels throughout the year were suitable for trout growth and survival.

Species sampled by netting, in order of occurrence, included: Utah chubs (74.1%), Utah suckers (23.7%), wild rainbow trout (0.7%), brown trout (0.4%), hatchery rainbow trout (0.2%) and all others ≤0.1%.

Three comparative evaluations were made between catchable-size Hayspur rainbow trout, Henrys Lake cutthroat trout, Sand Creek rainbow trout, generic rainbow trout, finespot cutthroat trout and Mt. Lassen rainbow trout. Hayspur rainbow trout had good return rates, were more vulnerable to bank anglers and were recommended for future reservoir enhancement.

Stocking the reservoir with 12,745 catchable-size trout and 79,000 fingerling trout increased the annual catch rate from 0.41 fish/hr during 1980 to 0.65 fish/hr during 1985. Fishing pressure during this interval increased from 4,685 hours to 12,631 hours annually. Stocking 25,000 catchable-size trout and 60,000 fingerlings in 1986 increased the catch rate to 0.95 fish/hr and increased fishing pressure to 15,307 hr/year.

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INTRODUCTION

Utah Power and Light Company recently applied to the Federal Energy Regulatory Commission (FERC) to relicense the Ashton-St. Anthony Water Power Project (Ashton Dam and Reservoir). Past observations have shown the reservoir fishery to be inferior to that of nearby free-flowing stretches of the Henrys Fork Snake River. As part of this relicensing procedure, Utah Power and Light funded a research project through the Idaho Department of Fish and Game to evaluate the reservoir fishery and compare findings to adjacent upstream and downstream river reaches. Study results will be used to determine whether enhancement of the reservoir fishery is feasible or if enhancement should be off-site. If reservoir enhancement is feasible, management alternatives will be proposed to return the fishery to levels similar to adjacent river reaches (catch rate of 1 fish/hr and a mean size of 25 to 30 cm).

OBJECTIVES

1. To characterize the limnology of the reservoir in order to evaluate the trout habitat.
2. To compare various strains of rainbow and cutthroat trout for suitability of enhancing the reservoir fishery.
3. To determine a stocking rate that will result in a catch rate of 1.0 fish/hr and fish averaging 25 to 30 cm in length.

RECOMMENDATIONS

1. Stock reservoir annually with 29,194 Hayspur rainbow trout averaging 315 mm (based on 1986 fishing pressure).
2. Adjust stocking to match changes in fishing pressure.
    A. Increase or decrease stocking to match change in population. Population estimates for five county areas around Ashton are presented in Shoro and Bostock (1985).
    B. Conduct creel surveys at five-year intervals to estimate fishing pressure, return rates of stocked trout, catch rate and harvest rate.
3. Increase access to the midsection of the reservoir.
4. Continue efforts to improve the brown trout population in Henrys Fork that provide a trophy aspect to the Ashton Reservoir fishery.

DESCRIPTION OF STUDY AREA

Ashton Reservoir is located approximately 4 km northwest of Ashton in Fremont County, Idaho (Fig. 1). The 20 m high dam backs up water for 6.7 km on the Henrys Fork of the Snake River. The dam became operational in 1918 and contains three turbines capable of producing a total of 5.8 MW of power. Normal maximum surface water elevation of the reservoir is 1,572 m and surface area at this elevation is 163 hectares. Mean monthly inflow between 1961 and 1983 varied from 30 m^3/second in January to 84 m^3/second in May. At these rates the retention time for the reservoir ranged from 1.6 days in May to 4.5 days in January.

The reservoir has 19.7 km of shoreline and a shoreline development of 4.4 km (Wetzel 1975). A maximum depth of 16.5 m was measured immediately above Ashton Dam and the mean depth was 7.3 m. Total dissolved solids (TDS), determined by a water sample analyzed by Idaho Department of Health and Welfare, was 121 ppm. Based on TDS and mean depth, a morphoedaphic index of 5.0 was calculated (Ryder 1965).

The Henrys Fork is the only large tributary and has a drainage area above the reservoir of 2,694 km^2. During 1985, the reservoir was ice-covered from December to February and was generally safe for fishermen in the lower sections.

METHODS

Reservoir Limnology

A Yellow Springs Instrument Company temperature-conductivity meter (Model 33) and an oxygen meter (Model 57) were used to measure water quality profiles. Measurements were recorded at 1 m depth intervals. Both meters were calibrated before each survey. A standard 20 cm Secchi disc was used to measure water transparency. Plankton samples were collected using a 1/2 m net (130 micron aperture) equipped with a pigmy flow meter. Samples were collected monthly between April 1986 and January 1987 and all cladocerans, copepods, nauplii and rotifers were used in density estimates. Tows were made from 1 m off the bottom to the surface and the water volume filtered was calculated from flow meter readings. Sampling stations were located at the upper, middle and lower thirds of the reservoir (Fig. 1). In addition, summer plankton samples were collected in each of the three bays on the northwest side of the reservoir.

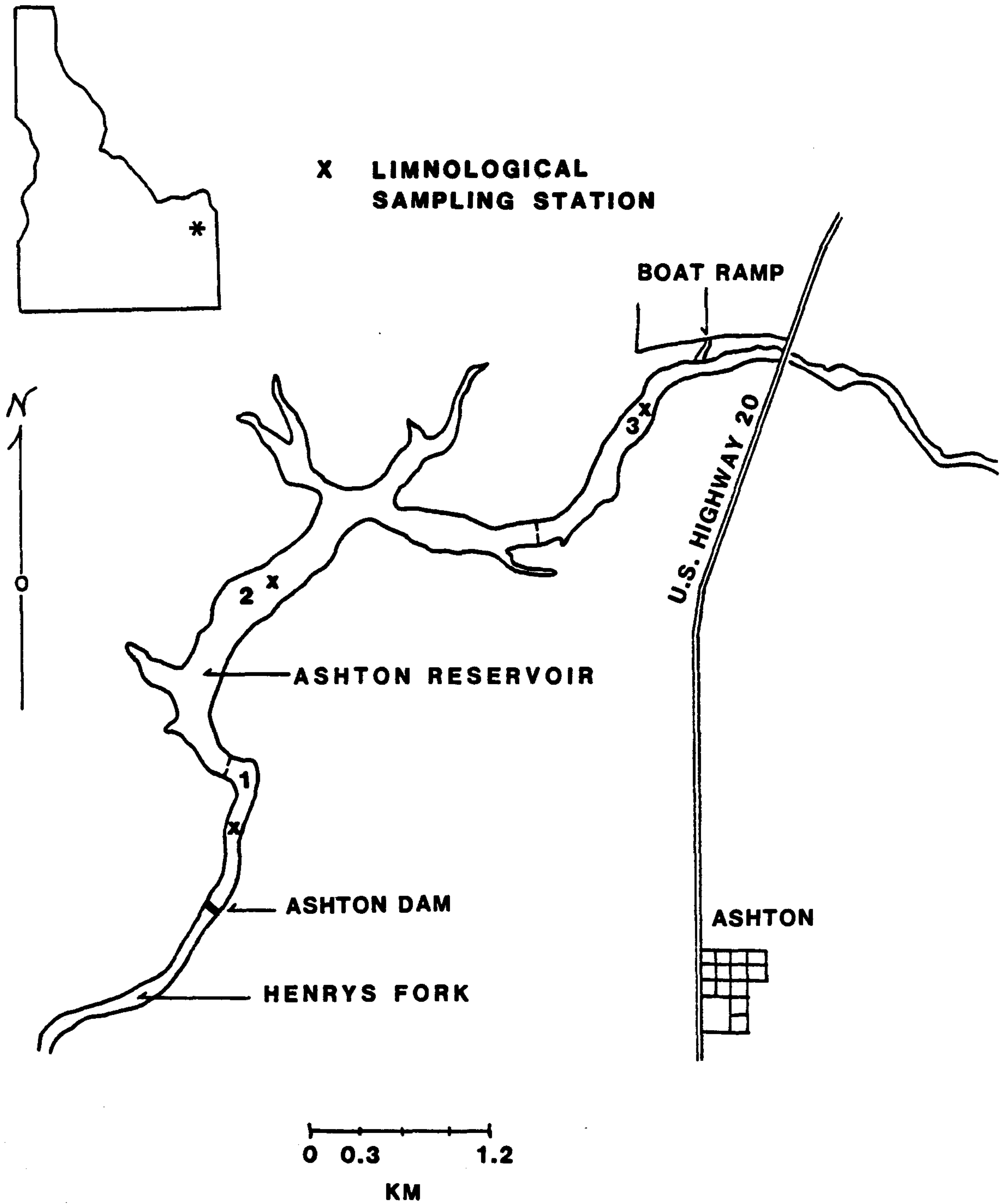

Figure 1. Ashton Reservoir, Idaho, showing location of three creel survey sections and limnological sampling sites.

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Creel Survey

A stratified random creel survey was conducted on Ashton Reservoir from May 11, 1985 to January 2, 1987. The total time period was divided into two-week intervals. Surveys were conducted on 50% of the weekend days, 20% of the weekdays and most holidays. Survey days were divided into four equal quarters, with one randomly selected time chosen during each quarter for angler counts. Counts were summarized by lake section and angling method (boat, bank, or ice). We interviewed fishermen between counts and gathered information for length of time fished, number of fish caught, type of gear used, angler residency, opinion of fishery and length and strain of fish caught. Total angler hours for each interval were estimated by multiplying the mean angler count per day type (weekday, weekend day, or holiday) by the number of days of that type, by the mean day length for the interval and summing the estimates. Estimated harvest of each strain for each interval was calculated by multiplying total angler hours by the catch rate for that strain. The total estimated harvest of each strain was divided by the number stocked to determine the percent return.

Strain Evaluation

Nine strains of rainbow and cutthroat trout were evaluated for their potential to enhance the Ashton Reservoir fishery: (1) Bear Lake cutthroat trout, (2) finespot cutthroat trout, (3) Henrys Lake cutthroat trout, (4) Hayspur rainbow trout, (5) Mt. Shasta rainbow trout, (6) Sand Creek rainbow trout, (7) Kamloops rainbow trout, (8) Mt. Lassen rainbow trout, and (9) generic rainbow trout. The histories and origins of these strains are described in Appendix A.

Trout Stocking

Five strains of catchable-size trout were stocked into the reservoir during 1985: (1) 3,000 Hayspur rainbow trout, (2) 3,150 Sand Creek rainbow trout, (3) 2,100 generic rainbow trout, (4) 1,500 Henrys Lake cutthroat trout, and (5) 2,995 finespot cutthroat trout (Table 1). Comparisons were made between these five strains based on percent return.

Four strains of catchable-size trout were evaluated during 1986. Three thousand each of finespot cutthroat trout, Hayspur rainbow trout, Mt. Lassen rainbow trout and generic rainbow trout were stocked on June 13, 1986 (Table 1). A second stocking of 2,000 each of the four strains was made on July 11, 1986. Direct comparisons were made between each of these four strains.

Table 1. Trout strains stocked into Ashton Reservoir during 1985 and 1986.

Species	Strain	Mark	Size	Date stocked	Number	Number marked
cutthroat	Henrys Lake	Adipose clip	catchable	5/22/85	1,500	684
rainbow	Hayspur	Jaw tag	catchable	6/17/85	3,000	1,500
rainbow	Sand Creek	Jaw tag	catchable	6/3/85	3,150	1,500
rainbow	generic	Jaw tag	catchable	5/29/85	2,100	700
cutthroat	Finespot	Jaw tag	catchable	7/22/85	2,995	1,500
rainbow	Mt. Shasta	Left ventral clip	fingerlings	6/26/85	20,000	all
rainbow	Hayspur	Right ventral clip	fingerlings	6/19/85	20,085	20,000
cutthroat	Finespot	Left ventral clip	fingerlings	7/22/85	9,985	all
cutthroat	Bear Lake	Right ventral clip	fingerlings	7/15/85	8,835	all
cutthroat	Henrys Lake	Adipose clip	fingerlings	9/17/85	20,000	all
cutthroat	Finespot	Adipose clip	catchable	6/13/86	3,000	all
rainbow	Hayspur	Adipose & left ventral clip	catchable	6/13/86	3,000	all
rainbow	Mt. Lassen	Adipose & right ventral clip	catchable	6/13/86	3,000	all
rainbow	generic	Adipose clip	catchable	6/13/86	3,000	all
rainbow	generic	caudal punch	catchable	3/18/86	2,000	all
cutthroat	Flnespot	Adipose clip	catchable	7/11/86	2,000	all
rainbow	Hayspur	Adipose & left ventral clip	catchable	7/11/86	2,000	all
rainbow	Mt Lassen	Adipose & right ventral clip	catchable	7/11/86	2,000	all
rainbow	generic	Adipose clip	catchable	7/11/86	2,000	all
rainbow	Hayspur	Left opercle punch	catchable	8/8/86	2,500	all
rainbow	generic	Right opercle punch	catchable	8/8/86	2,500	all
rainbow	Hayspur	Left ventral clip	fingerlings	7/18/86	20,000	all
rainbow	Kamloops	Right ventral clip	fingerlings	7/18/86	20,000	all
cutthroat	Finespot	None	fingerlings	7/25/86	20,000	all

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A third comparison was made between catchable-size generic rainbow trout and pond-reared Hayspur rainbow trout. Two thousand, five hundred of each were stocked on August 8, 1986. All catchable-size trout were evaluated based on return to the creel, whether they contributed to the boat or bank fishery and uniformity of harvest over time.

Five strains of fingerling trout were also stocked during 1985 (Table 1). They included: (1) 20,000 Mt. Shasta rainbow trout, (2) 20,085 Hayspur rainbow trout, (3) 9,985 finespot cutthroat trout, (4) 8,835 Bear Lake cutthroat trout, and (5) 20,000 Henrys Lake cutthroat trout. During 1986, 20,000 each of Hayspur rainbow trout, Kamloops rainbow trout and finespot cutthroat trout were stocked in July. Angler harvest and gilinetting during the year following stocking were used to evaluate the recruitment into the fishery and survival of the fingerlings.

Fish Sampling

Gill nets, electrofishing with backpack and boat-mounted gear and a Lake Merwin trap net were used to sample reservoir fish stocks and determine relative abundance. Vertical, monofilament and variable mesh gill nets were set at the lower two sections of the reservoir to determine fish depth distributions. (The upper section had insufficient depth for vertical nets.) These vertical nets were 1.8 m wide and had five 3 m panels of 2.5 cm, 3.2 cm, 3.8 cm, 4.4 cm and 5.1 cm bar mesh. Horizontal nets were 18.3 m and 36.6 m in length and were made of six panels of 1.9 cm, 2.5 cm, 3.2 cm, 3.8 cm, 4.4 cm and 5.1 cm bar mesh monofilament. They were used to sample fish in all three reservoir sections.

Reservoir Currents

Surface currents in Ashton Reservoir were measured because much of the reservoir limnology was influenced by high inflows. Floating drogues of one meter in length were released at various locations and timed as they passively moved with the surface currents (Fig. 2). Drogue locations were plotted on reservoir maps and current speeds determined by dividing distance moved by time between sightings. The drifting of 15 drogues was recorded on August 20, 1986 from 0850 to 1537.

Diet Analysis

Food habits of hatchery and wild trout were examined to gain insights into their survival within Ashton Reservoir. Stomach contents of individual angler-creeled fish were bottled, labeled by strain and preserved in ethanol for later analysis. Contents were categorized as zooplankton, insects, fish, bait, other material (e.g., vegetation, wood, snails, rock, pine needles, algae, plastic and inorganic material), or empty. Food habit analysis began two weeks after the trout were stocked.

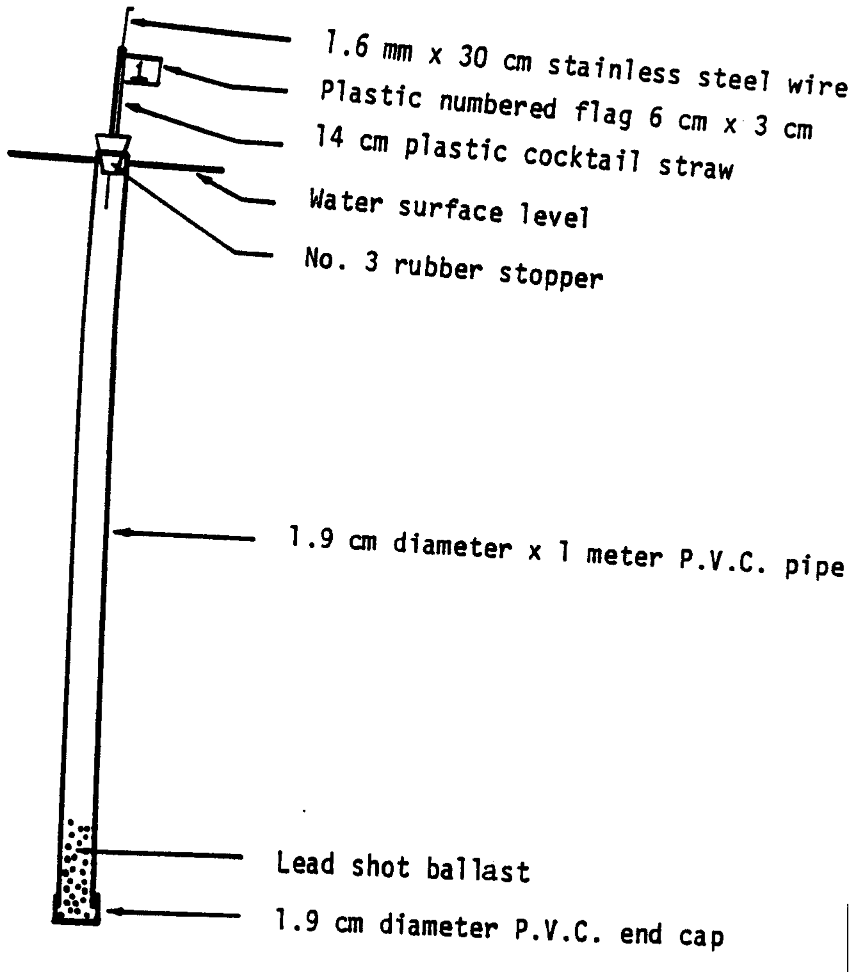

Figure 2. Drogue used to measure Ashton Reservoir surface currents.

RESULTS

Reservoir Limnology

Ashton Reservoir water temperatures peaked at 20.5 C during June and July of 1985 and at 17.4 C during August 1986. These high temperatures were recorded near the surface in Section 1. Surface temperature increased 1 to 3 C from upper to lower sections. Lowest temperatures were recorded during December 1985 and January 1986 when the entire water column was <1 C (Fig. 3 and Appendix B).

Only during June of 1985, at depths below 10 m, were oxygen levels less than 5 mg/liter in Section 1 (Fig. 4). During the following 19 months of study, oxygen concentrations throughout the water column were much greater. A peak oxygen concentration of 11.6 mg/liter occurred during December 1986. The exception to these high oxygen values occurred on the reservoir bottom where readings below 1 ppm frequently occurred.

The reservoir did not appear to thermally stratify during the summer of 1985 or 1986 because no sharp changes in temperature or oxygen profiles were recorded (Figs. 3 and 4). No inverse stratification was detected during the midwinter of either year.

Secchi transparency readings ranged from 1.4 m during April 1985 to 4.8 m during December 1986. Clearest water was recorded during the fall and winter, with the most turbid water occurring during spring runoff (Fig. 4). Generally, transparency readings were similar at each of the three sampling stations.

Reservoir conductivity at Station 1, mid-depth, averaged 86 umhos/cm for the study period and ranged from 59 to 145 umhos/cm. Lowest readings were recorded during spring runoff: April 1986 = 60 and May 1986 = 59. Highest readings were recorded during midsummer: June 1985 = 110 and July 1985 = 102; July 1986 = 100 and August 1986 = 102 (Appendix B).

Surface currents of 36 m/minute were measured above the county boat dock, but decreased to 20 m/minute at the middle of Section 3 and further decreased to 17 m/minute at the lower end of the section. Surface currents in Section 2 moved up or down the reservoir, depending on wind direction. Current speeds in this section ranged from 1 to 2 m/minute. In the lower section, currents moved toward Ashton Dam at speeds ranging from 2 to 4 m/minute (Fig. 5).

Zooplankton densities in April and May averaged 0.14 organisms/liter at Station 1 and 0.01 organisms/liter at Station 2. Peak densities of 6.62 organisms/liter occurred in August at Station 1 and a peak density of 2.72 organisms/liter occurred in June at Station 2. Plankton densities dropped to an average of 0.04 organisms/liter between November and January at Station 1 (Fig. 6 and Appendix C). Densities over 100 organisms/liter were recorded in Cedar Gulch, Rattlesnake Bay and Willow Creek Bay during the summer. A maximum density of 201 organisms/liter was recorded in Willow Creek Bay in August (Appendix C).

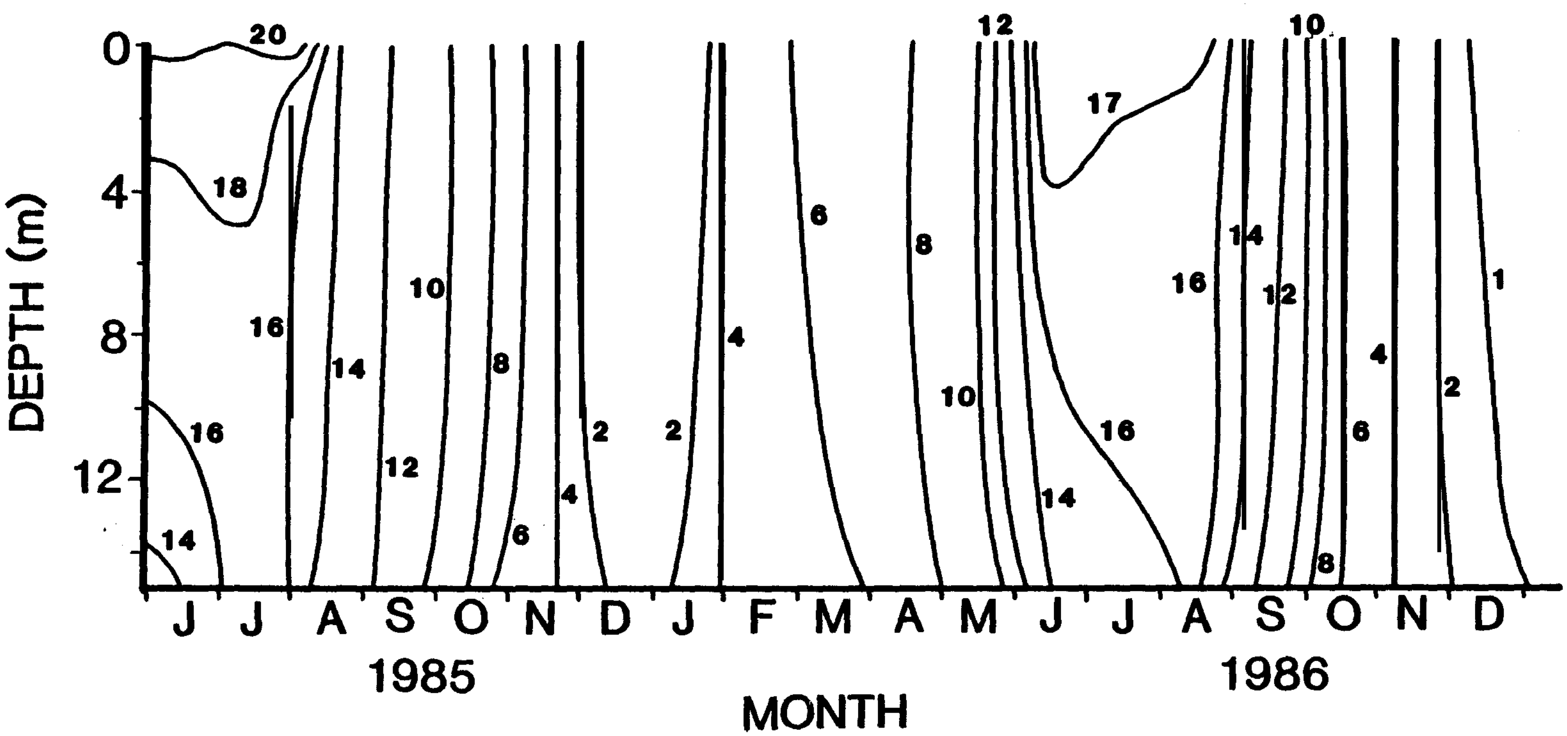

Figure 3. Monthly temperature profile (C) for the lower end of Ashton Reservoir, June 1985 to January 1987.

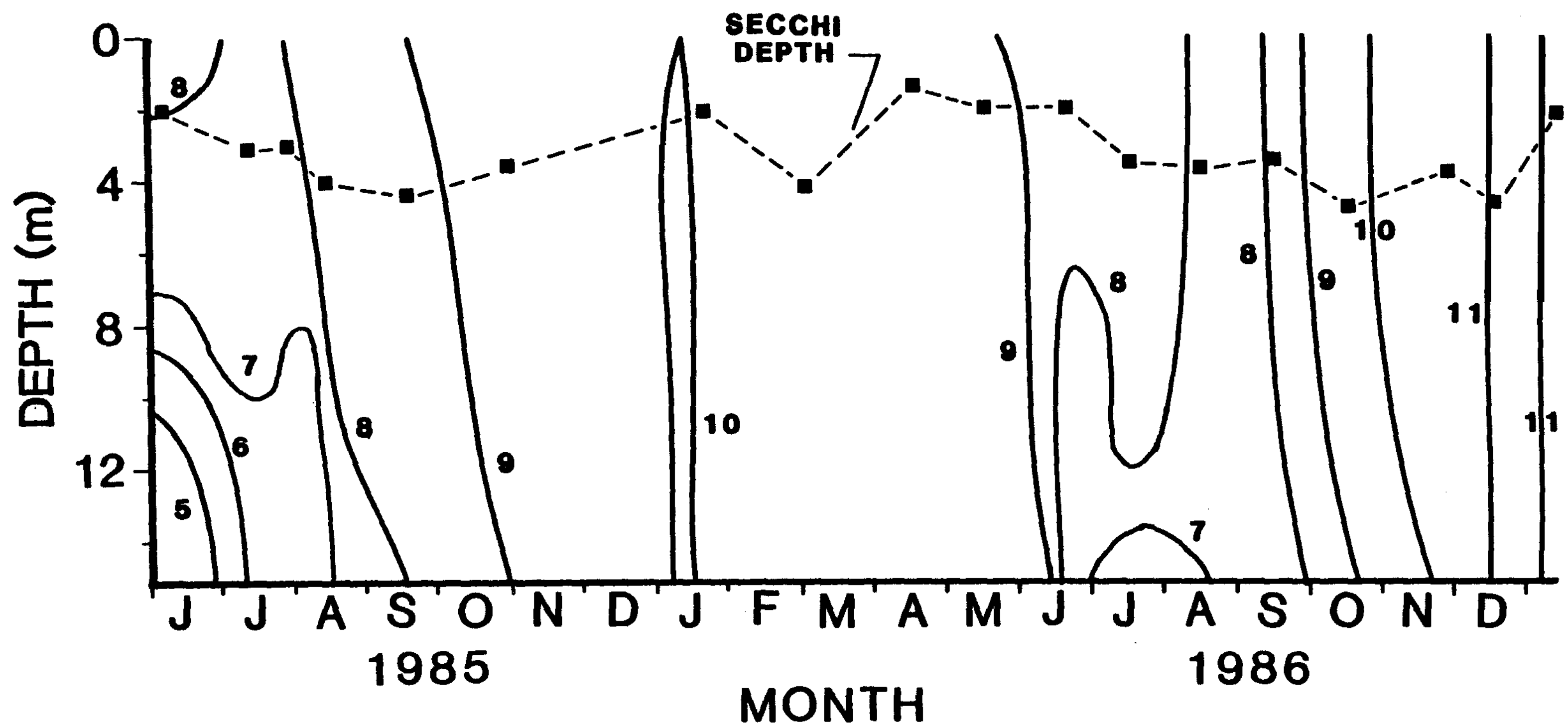

Figure 4. Monthly oxygen profile (mg/liter) and Secchi depth for Ashton Reservoir, June 1985 to January 1987.

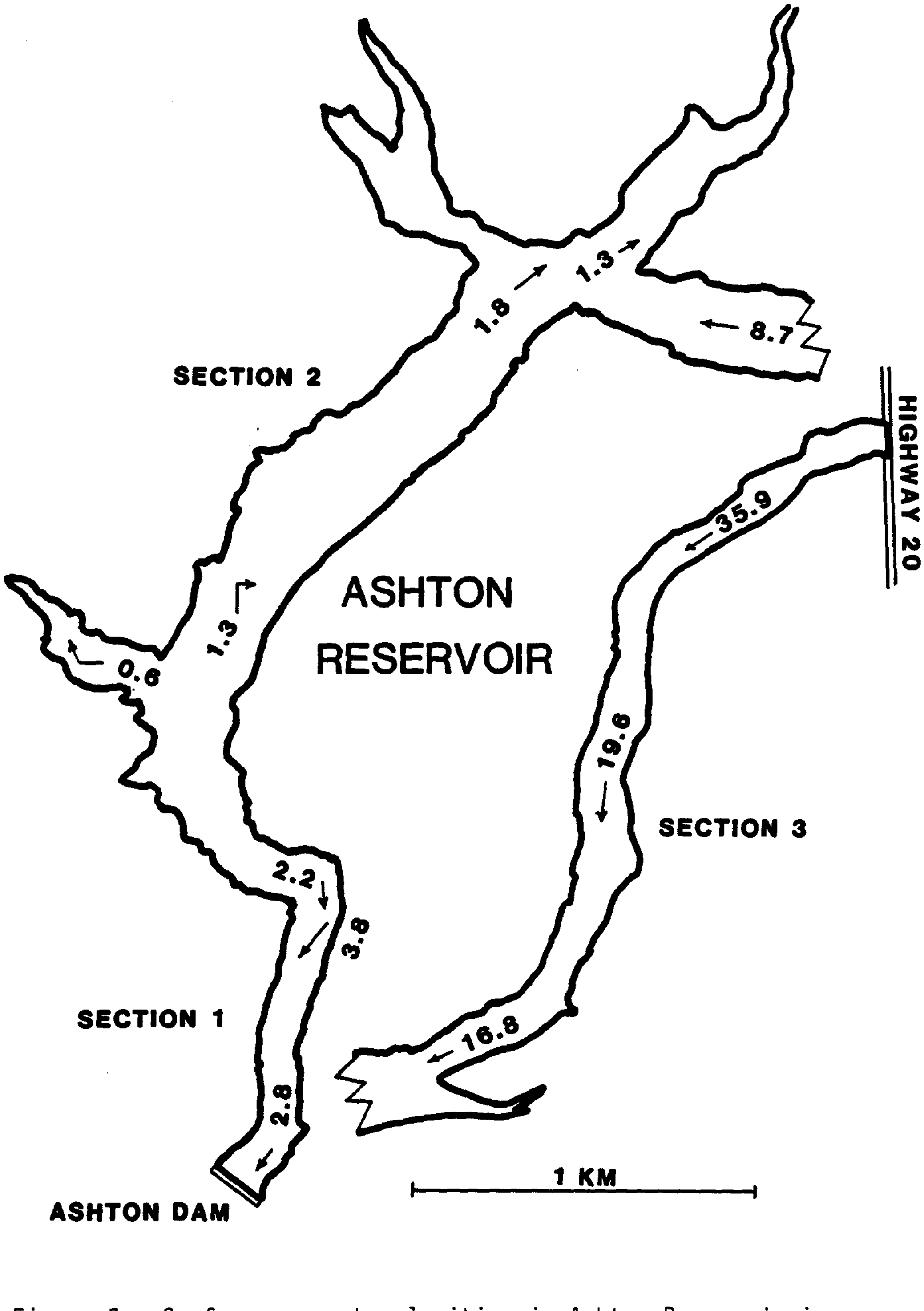

Figure 5. Surface current velocities in Ashton Reservoir in m/minute on August 20, 1986. Arrows indicate direction of flow.

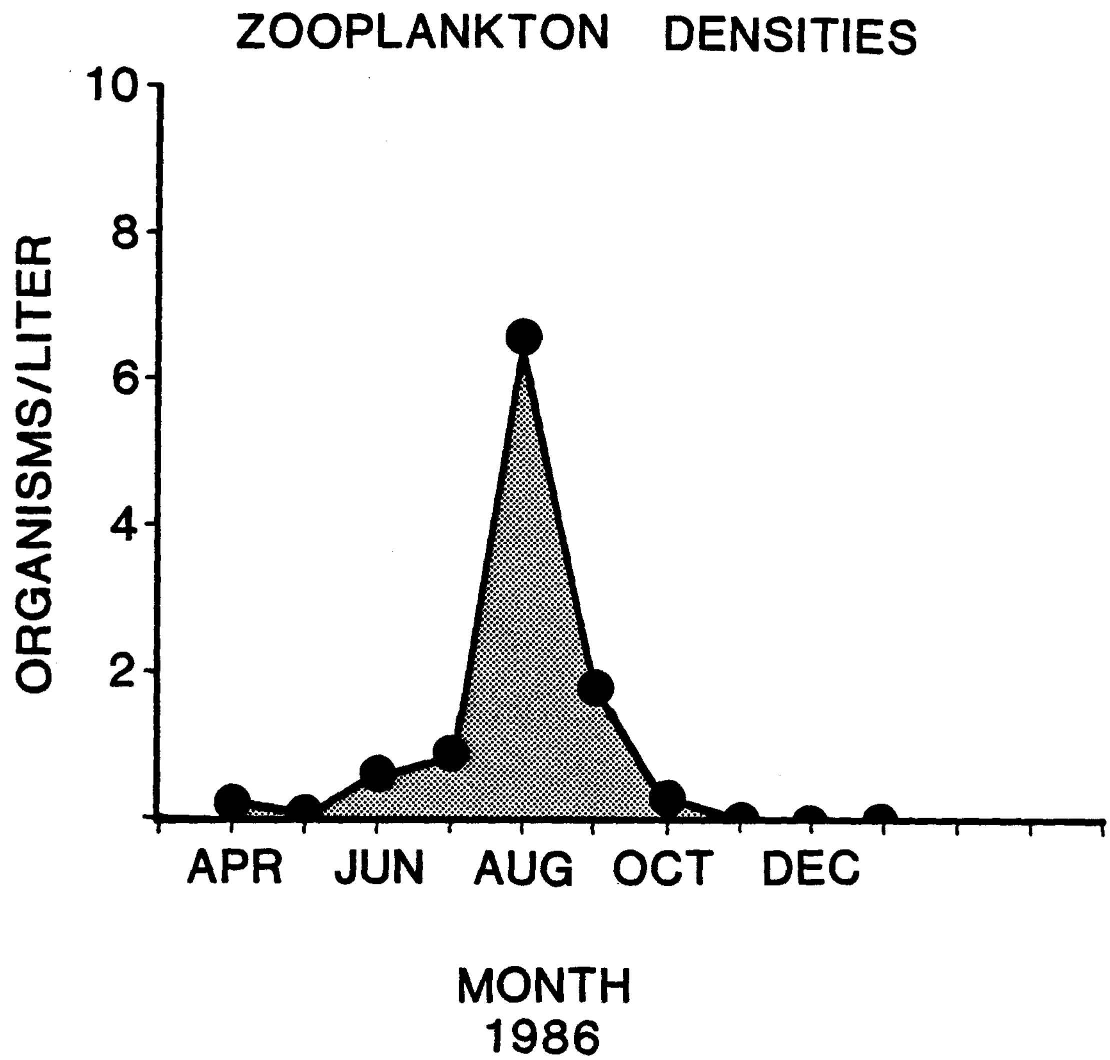

Figure 6. Zooplankton densities at the lower end of Ashton Reservoir, Idaho, from April 1986 to January 1987.

Creel Survey

A total of 12,631 hours of fishing effort were expended on Ashton Reservoir between May 1985 and May 1986. Pressure increased 21% to 15,307 hours during 1986 (Fig. 7). Peak fishing effort occurred during June, July and August, with a maximum effort of 1,958 hours/two-week interval (July 12, 1986 to July 25, 1986). Lowest fishing efforts occurred during spring runoff (May) and when ice was forming (December).

During 1986, 70% of the fishing pressure occurred at the upper end of the reservoir where easy access was available and the least amount (13%) occurred in the lower section (Appendix D). However, 76% of fishing pressure in midwinter occurred in the lower section where ice was the safest. Boat, bank and ice fishermen made up 31%, 66% and 3% of the fishing effort, respectively (Appendix D).

Of the 2,278 anglers interviewed during the 20 months of creel survey, 73% were Idaho residents. From October to May, 99% were residents, but this figure declined to 68% from May to October. Nonresident anglers fishing Ashton Reservoir were from 32 states (Table 2). Most nonresidents were from Arizona (50%), Utah (12%), California (10%), Wyoming (4%), Oregon (4%) and Colorado (4%).

When asked to rate the fishing during 1985, the most frequent response (37%) was "poor". During 1986, the most frequent response (29%) was "good". Low abundance of fish was the reason most anglers (48%) gave for fair or poor fishing. When asked if fishing had improved, 22% of the anglers during 1985 said it had, but this percent dropped to 6% during 1986 (Table 3).

The first stocking of 12,745 catchable-size trout occurred during the spring of 1985. Catch rate increased from 0.4 fish/hr to 0.9 fish/hr following release. Catch rate declined throughout the summer as more of these stocked trout were harvested (Fig. 8). During ice fishing season, catch rate peaked at 3.5 fish/hr. This increase in catch rate was largely attributed to the salmon that migrated downstream from Island Park Reservoir. The average catch rate from May 1985 to May 1986 was 0.65 fish/hr. Catch rates continually declined throughout the spring of 1986 to a low of 0.1 fish/hr in April (Fig. 9).

The stocking of 12,000 catchable-size trout during June, along with 8,000 catchable-size trout and 60,000 fingerling trout during July and 5,000 catchable-size trout during August, kept the catch rate at 1.0 fish/ hr throughout most of the summer of 1986. Catch rate increased during the winter of 1986 to a high of 3.0 fish/hr (Fig. 9). The high winter catch rate in 1986 was also due to migrating salmon. Mean catch rate for 1986 was 0.95 fish/hr. Harvest rate generally followed catch rate. Fishermen kept most of the fish they caught if they were large enough; thus, the difference between the two rates indicates the presence of small fish in the catch. This was particularly apparent during September and October 1986 when anglers were catching and releasing numerous fingerlings from the July stocking (Fig. 9).

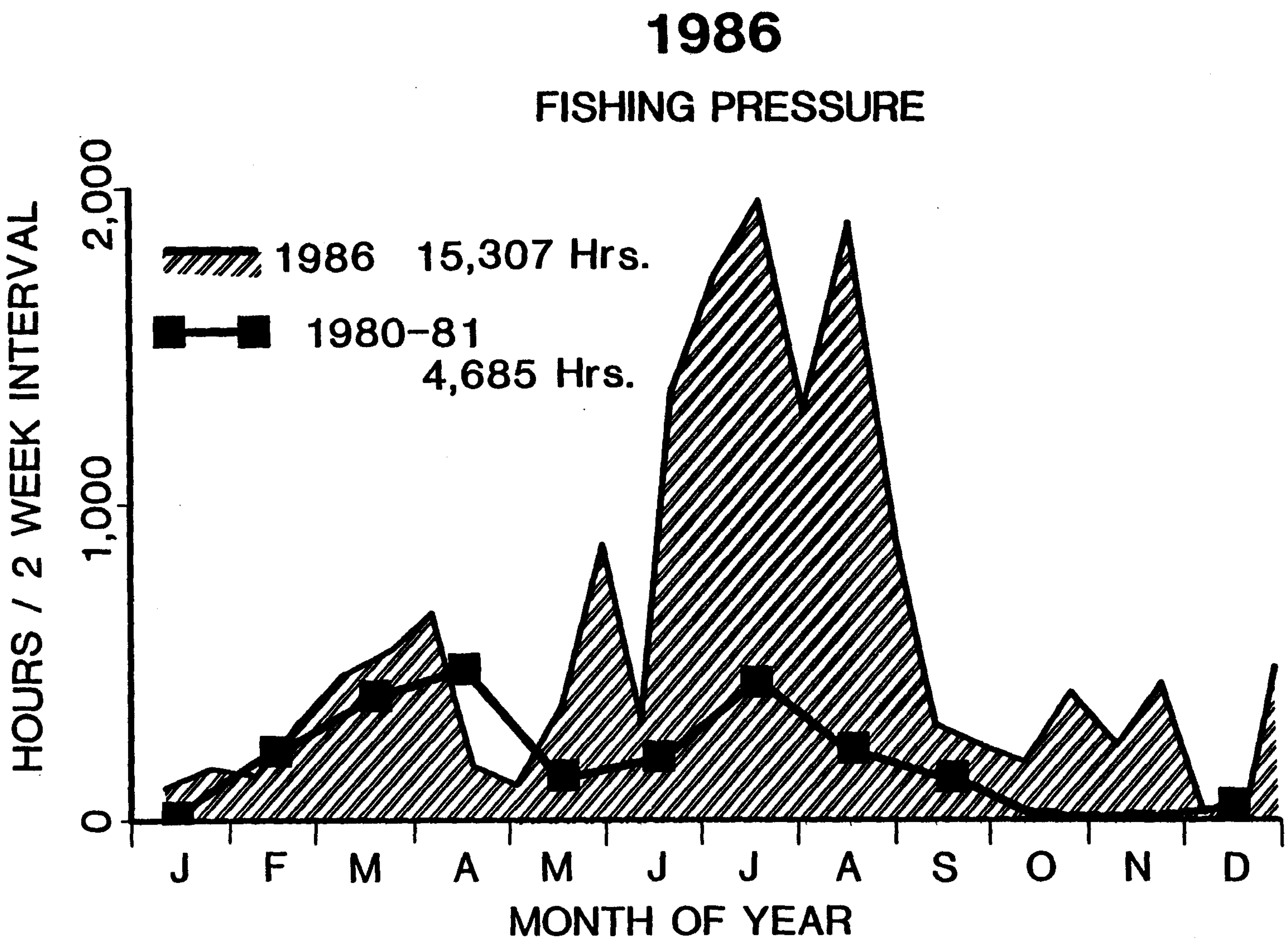

Figure 7. Hours of fishing pressure on Ashton Reservoir, Idaho, during each two-week creel survey interval. Data from 1980-1981 included for comparison (Rohrer 1981).

Table 2. Home state and percent of nonresident anglers who fished Ashton Reservoir, Idaho, 1986.

State	Percent
Arizona	50
Utah	12
California	10
Wyoming	4
Oregon	4
Colorado	4
Texas	3
Nevada	2
Montana	1
Washington	1
Nebraska	1
Maryland	1
New Jersey	1
New Mexico	1
Arkansas	1
Michigan	<1
Ohio	<1
Indiana	<1
North Dakota	<1
Virginia	<1
Massachusetts	<1
Pennsylvania	<1
Connecticut	<1
North Carolina	<1
South Dakota	<1
Rhode Island	<1
Kentucky	<1
Georgia	<1
Minnesota	<1
New York	<1
Oklahoma	<1

Table 3. Angler responses to three questions about fishing Ashton Reservoir, Idaho, 1985-1986.

1. How do you rate fishing in Ashton Reservoir?

Dates	Number sampled	Percent response				
		Excellent	Good	Fair	Poor	No opinion
5/11/85 to 6/13/86	644	7	22	27	37	7
6/14/86 to 1/2/87	992	7	29	22	24	18
Totals	1,636	7	26	24	29	14

2. If fair or poor, reason?

Dates	Number sampled	Percent response			
		Size	Abundance	Size & Abundance	Othe
5/11/85 to 6/13/86	376	20	48	23	9
6/14/86 to 1/2/87	424	18	48	23	11
Totals	800	19	48	23	10

3. Has the fishing in Ashton Reservoir improved, declined or stayed the same during the last three years?

Dates	Number sampled	Percent response			
		Improved	Declined	Same	No opinion
5/11/85 to 6/13/86	566	22	13	20	45
6/14/86 to 1/2/87	930	6	4	13	77
Totals	1,496	12	7	16	65

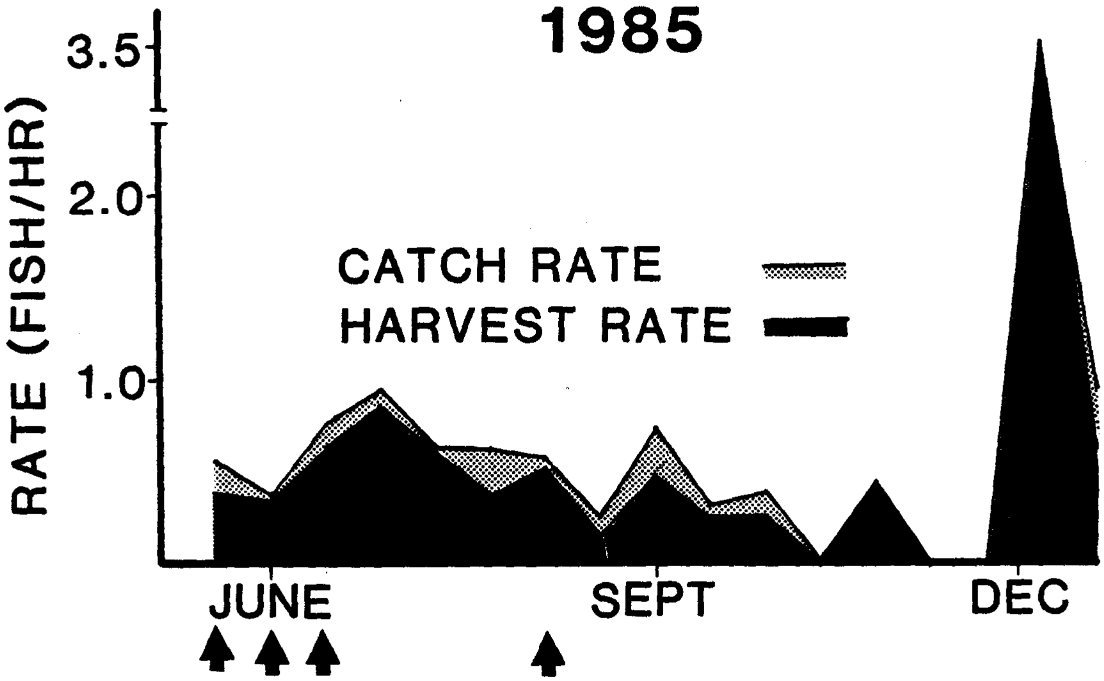

Figure 8. Catch rate and harvest rate for anglers fishing Ashton Reservoir, Idaho, 1985. Arrows indicate when fish were stocked.

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Strain Evaluation

The return to creel of five strains of trout stocked during 1985 was documented for 88 weeks after stocking (Appendix E). None of the trout strains, however, were harvested more than 50 weeks after stocking. Percent return for each strain 88 weeks after stocking was 53% for Hayspur rainbow trout, 41% for Sand Creek rainbow trout, 25% for generic rainbow trout, 20% for finespot cutthroat trout and 17% for Henrys Lake cutthroat trout (Fig. 10). Harvest of these trout for 18 weeks after stocking was analyzed by Friedman Two-Way Analysis by ranks (Appendix F). Highly significant differences ($P < 0.01$) existed between the four trout strains.

Harvest of four catchable-size trout strains stocked during 1986 was monitored for 30 weeks following release (Fig. 11 and Appendix G). Differences between strains were significant ($P < 0.10$ level) (Appendix H). Finespot cutthroat trout with a return rate of 18% were responsible for most of the difference. Similar percent returns were calculated for Hayspur rainbow trout (36%), Mt. Lassen rainbow trout (36%) and generic rainbow trout (46%).

On August 8, 2,500 pond-reared catchable-size Hayspur rainbow trout and 2,500 catchable-size generic rainbow trout were stocked into Ashton Reservoir. Return of these stocks was monitored for the next 22 weeks (Fig. 12 and Appendix I). The largest difference occurred during the first two weeks following release when 593 Hayspur rainbow trout were harvested versus 161 generic rainbow trout. At the end of the test, 36% of the Hayspur rainbow trout and 13% of the generic rainbow trout were caught. Numbers of trout harvested were compared by use of a sign test (Steel and Torrie 1960). Significantly more Hayspur rainbow trout were harvested ($P < 0.05$).

Harvest rate for each strain stocked in 1986 was calculated for ice, boat and bank anglers (Table 4). Finespot cutthroat trout were harvested at twice the rate by boat anglers as compared to bank anglers. Hayspur rainbow trout had a higher harvest rate for bank anglers during both of the 1986 tests. Mt. Lassen trout were harvested at nearly equal rates by boat and bank anglers, while generic trout appeared more susceptible to boat anglers.

Performance of 78,905 fingerling trout stocked during spring of 1985 was monitored throughout 1986. Hayspur and Mt. Shasta fingerlings had identical growth rates. During their first summer (June to September) in Ashton Reservoir, they grew at a rate of 23 mm/month. Over the winter (September to April), growth rates for both strains slowed to 3 mm/month. By March 26, 1986, Hayspur rainbow trout had attained a mean length of 181 mm and Mt. Shasta rainbow trout were 167 mm. A total of 156 fingerlings were harvested: 90 Hayspur, 41 Mt. Shasta, 16 Bear Lake and 9 Henrys Lake cutthroat. Overall return was 0.2% and fingerlings comprised 1.4% of the total number of fish harvested during 1986.

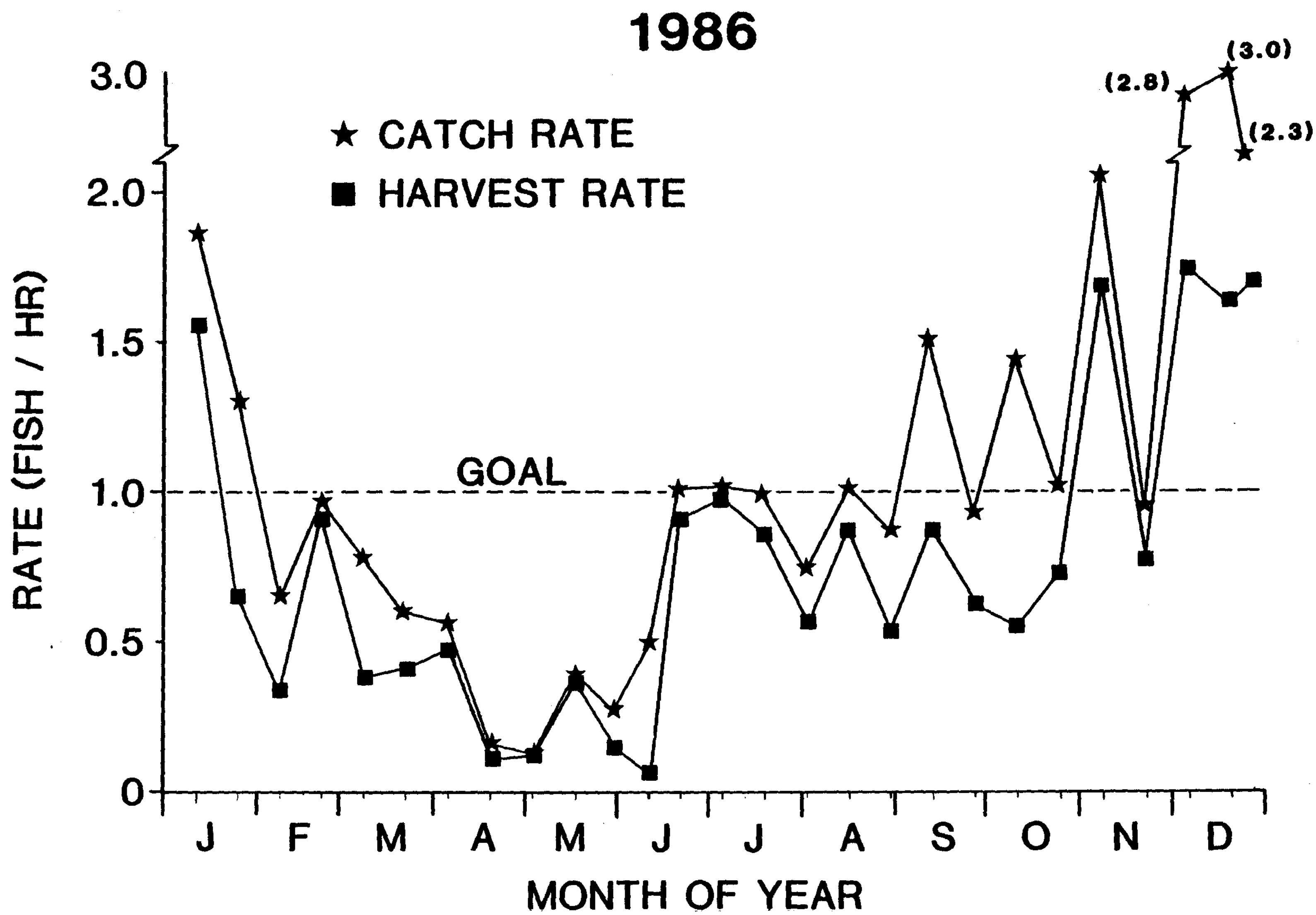

Figure 9. Catch rate and harvest rate for anglers fishing Ashton Reservoir, Idaho, 1986. The dashed horizontal line represents the goal of 1 fish/hr.

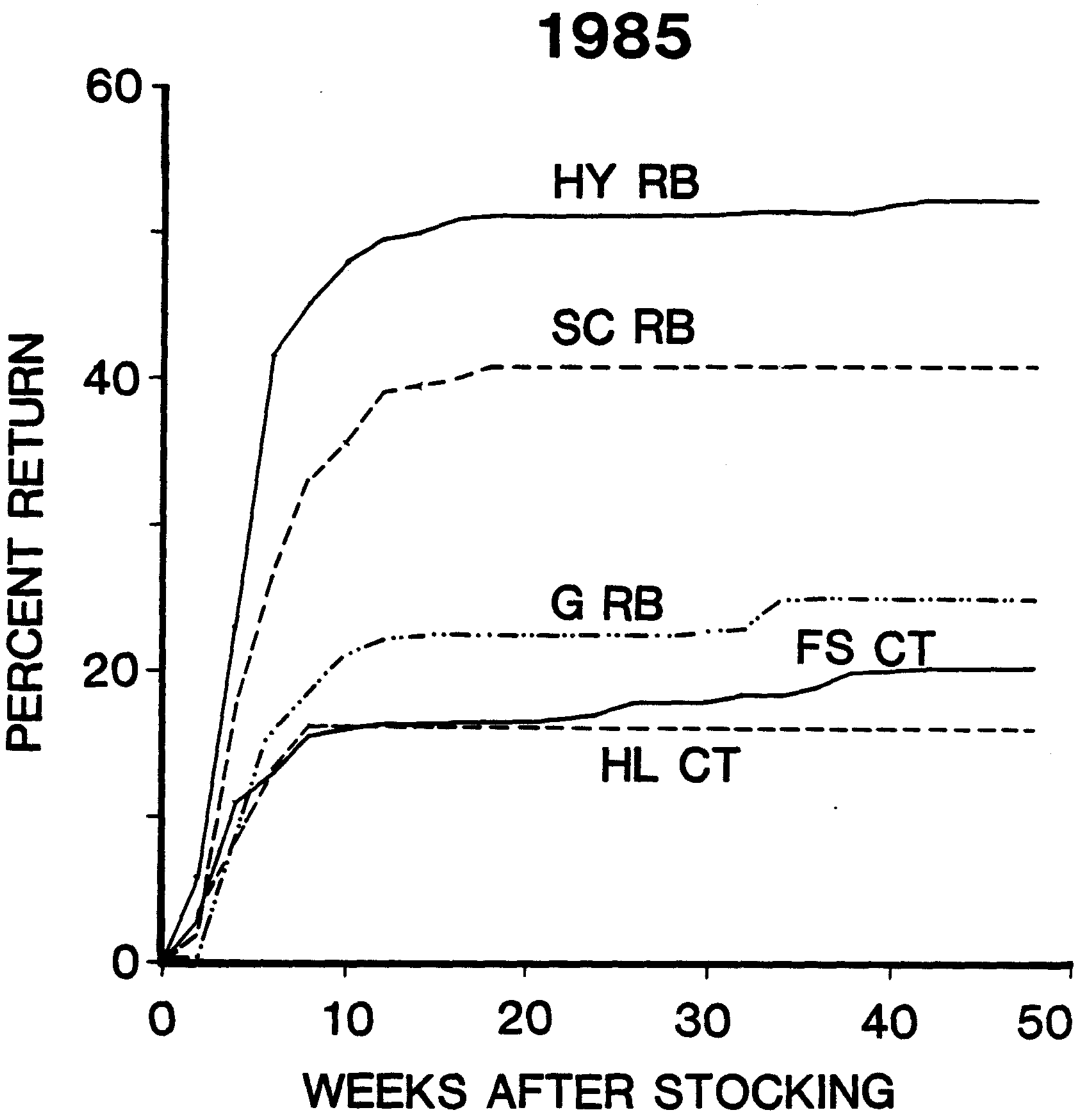

Figure 10. Cumulative percent return for each of five trout strains stocked as catchables in Ashton Reservoir, 1985. HY RB = Hayspur rainbow trout, SC RB = Sand Creek rainbow trout, G RB = generic rainbow trout, FS CT = finespot cutthroat trout and HL CT = Henrys Lake cutthroat trout.

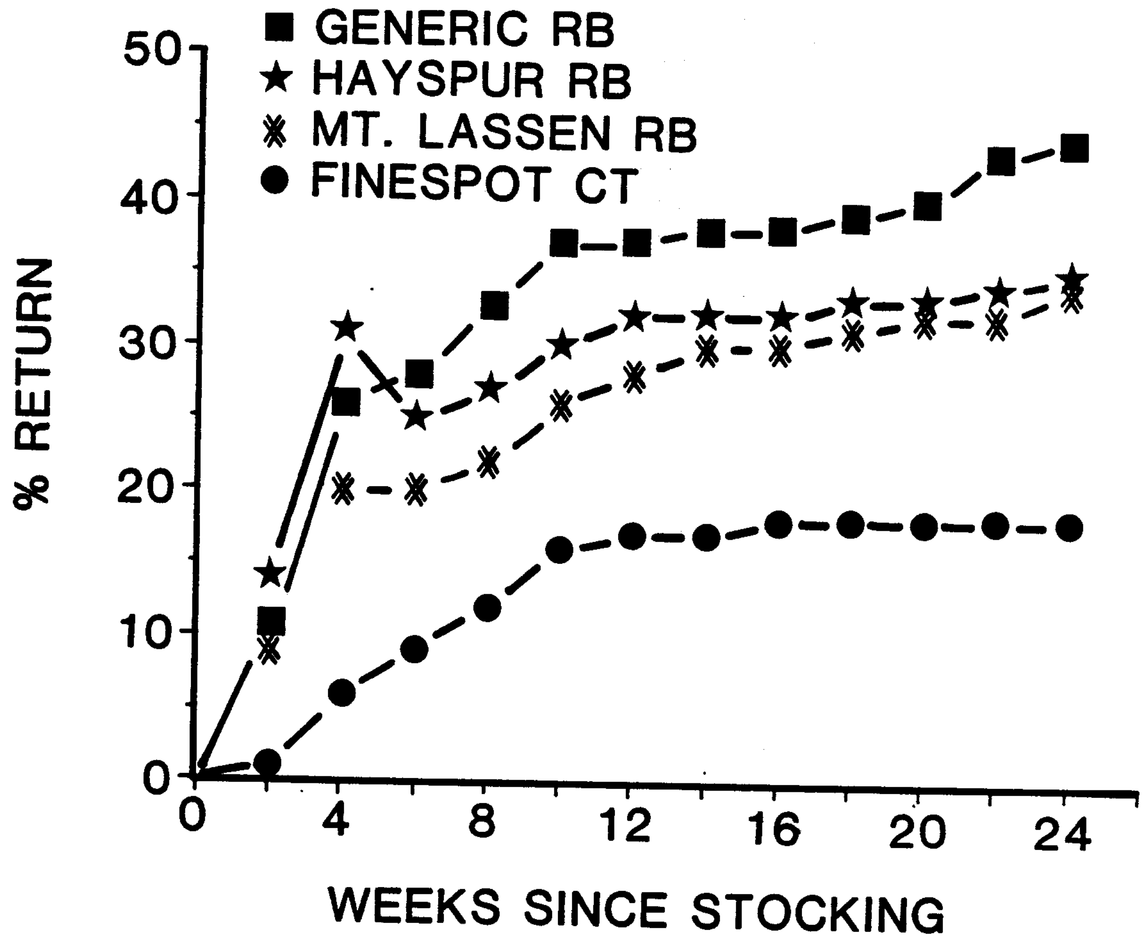

Figure 11. Cumulative percent return of four strains of catchable-size trout stocked into Ashton Reservoir, Idaho, 1986. RB = rainbow trout and CT = cutthroat trout.

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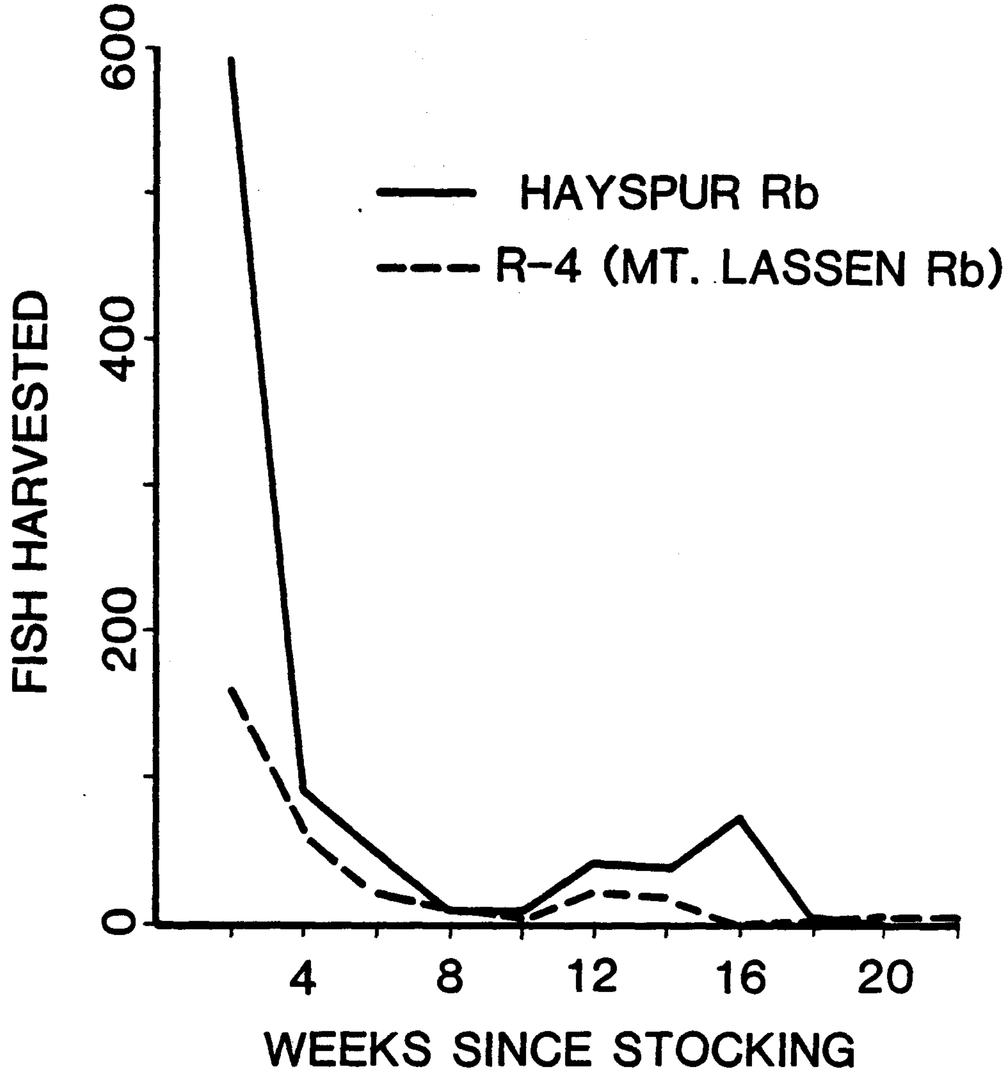

Figure 12. Harvest of two strains of catchable trout from Ashton Reservoir, Idaho. Rb = rainbow trout and R-4 = generic rainbow trout from the Mt. Lassen Trout Farm.

Table 4. Harvest of various trout strains stocked into Ashton Reservoir, June 1986 to January 1987.

Type of anglers	Strains						
	Finespot cutthroat[a]	Hayspur rainbow[a]	Mt. Lassen rainbow[a]	Generic rainbow[s]	Hayspur (pond-reared) rainbow[b]	R[4] (generic rainbow)[b]	Total[c]
Bank							
Number	100	258	236	250	121	35	
Harvest rate	0.065	0.168	0.154	0.163	0.079	0.023	0.749
Boat							
Number	80	77	99	177	28	23	
Harvest rate	0.121	0.116	0.150	0.267	0.042	0.035	0.851
Ice							
Number	2	5	8	7	0	2	
Harvest rate	0.056	0.0140	0.0225	0.0197	0	0.056	1.882
Total							
Number	182	340	343	434	149	60	
Harvest rate	0.082	0.152	0.154	0.195	0.067	0.027	0.797

[a]Stocked 6/13/86 and 7/11/86
[b]Stocked 8/8/86
[c]Includes all game species harvested

Fish Sampling

Trapnetting and gillnetting were conducted during June and July 1985 mostly prior to stocking the reservoir with catchable-size trout strains. A total of 3,716 fish were collected and included:

1. Utah chubs (Gila atraria), 74.1%;
2. Utah suckers (Catostomus ardens), 23.7%;
3. wild rainbow trout (Salmo gairdneri), 0.7%;
4. brown trout (Salmo trutta), 0.4%;
5. brook trout (Salvelinus fontinalis), 0.4%;
6. hatchery rainbow trout, 0.2%;
7. sculpins (Cottus bairdi), 0.1%;
8. fathead minnows (Pimephales promelas), 0.1%;
9. redside shiners (Richardsonius balteatus), 0.1%;
10. mountain whitefish (Prosopium williamsoni), 0.1%;
11. kokanee salmon (Oncorhynchus nerka), <0.1%; and
12. dace (Rhinichthys cataractae), or (Rhinichthys osculus), <0.1%.

During the fall of 1986, 884 fish were gillnetted in 15 net-nights (Table 5). Similar to the 1985 sampling, the majority of fish (61%) were Utah chubs. Other species, listed by decreasing frequency, were: (1) Utah suckers (33%), (2) wild rainbow trout (1.5%), (3) brown trout (1%), (4) Kamloops rainbow trout fingerlings stocked during 1986 (1.1%), (5) Hayspur rainbow trout fingerlings stocked in 1986 (0.7%), (6) Mt. Lassen rainbow trout stocked in 1986 (0.7%), (7) generic rainbow trout stocked during 1986 (0.5%) and all others were 0.1% or less. With one exception, a Bear Lake cutthroat (348 mm and 350 g), no fingerling or catchable-size trout stocked during 1985 were netted. Utah chubs were much less frequently caught in the upper third of the reservoir than the lower two-thirds. Numbers of trout caught in vertical gill nets were insufficient to determine depth distributions.

Diet Analysis

Insects were the items found most frequently in the stomachs of both hatchery and wild trout (Table 6). Pine needles, wood, rock and algae were found in hatchery trout, but were also frequently found in the stomachs of wild trout. None of the trout examined relied on a zooplankton diet and few had empty stomachs. The most common items in Utah chub stomachs were algae (95%), macrophytes (3%), chironomids (2%) and cladocerans (1%).

Table 5. Number of fish by species and strain collected by gillnetting Ashton Reservoir during the fall of 1986. Section 1 = the lower end of the reservoir, Section 2 = mid-reservoir and Section 3 = the upper end of the reservoir.

Species[b] & strains	Net types[a] and sections																
	V 1	V 1	V 1	H 1	H 1	V 2	V 2	V 2	H 2	H 2	V 3	V 3	V 3	H 3	H 3	Tota	
Utah chub	5	0	0	67	126	0	4	0	303	16	0	10	2	6	0	539	61.0
Utah sucker	9	0	0	20	117	0	5	0	20	13	0	6	6	34	60	290	32.8
Brown trout	0	0	0	1	1	0	0	0	2	1	0	1	1	1	2	9	1.0
Brook trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Wild rainbow trout	0	0	0	0	3	0	0	0	5	0	0	0	0	4	1	13	1.5
Generic (C/86)	0	0	0	1	2	0	0	0	0	1	0	0	0	0	0	4	0.5
Kamloops (FG/86)	0	0	0	0	4	0	0	0	0	6	0	0	0	0	0	10	1.1
Hayspur (FG/86)	0	0	0	0	2	0	0	0	0	4	0	0	0	0	0	6	0.7
Salmon	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0.1
Mt. Lassen (C/86)	0	0	0	0	0	0	0	0	0	5	0	0	0	1	0	6	0.7
Bear L. cutthroat (FG/85)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0.1
Hayspur (C/86)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.1
Unknown hatchery rainbow	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.1
Finespot cutthroat (C/86)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0.1
Generic rainbow (C/8/86)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.1
Hayspur (pond-reared, C/8/86)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0.1
Totals																884	100.0

[a]V = vertical monofilament gill net; H = horizontal monofilament gill net
[b]FG/85 = fingerlings stocked in 1985; FG/86 = fingerlings stocked in 1986; C/86 = catchable-size fish stocked in 1986; C/8/86 = catchable-size trout stocked in August 1986

Table 6. Frequency of occurrence (%) of food items in the stomachs of various trout strains stocked into Ashton Reservoir during the summer of 1986.

Food items	Hayspur rainbow trout	Mt. Lassen rainbow trout	Generic rainbow trout	Finespot cutthroat trout	Wild rainbow trout	Utahs chubs
	Fish strains					
Zooplankton	0	0	0	0	0	50
Insects	100	100	82	91	100	83
Fish	0	8	0	0	0	0
Bait[a]	68	46	27	18	33	0
Other[b]	100	69	91	82	83	100
Empty	0	0	21	0	0	0
Number	6	13	14	11	6	6

[a]includes corn, salmon eggs and worms
[b]includes vegetation, snails, wood, rock, pine needles, plastic and inorganic material

DISCUSSION

Reservoir Limnology

North temperate lakes of a size similar to Ashton Reservoir would typically be dimictic, meaning that the water column is mixed twice annually (Wetzel 1975). However, Ashton is atypical: it does not fall into any lake category and Iimnologicaliy behaves like a very deep stretch of river. Constant temperature and oxygen concentrations from top to bottom indicated internal turbulence sufficient to overcome thermal stratification. This continuous mixing would allow nutrients to be cycled from top to bottom, but would also pull phytoplankton out of the euphotic zone (the upper sunlit section of the water column) and inhibit its production.

Conductivity readings averaging 86 umhos/cm and a morphoedaphic index of 5.0 would indicate the reservoir could be a moderately productive system (Ryder 1965). A mean depth of 7.3 m and a shoreline development of 4.4 km would give similar indications. Rawson (1955) regarded mean depth as the best single index to plankton density and found a strong correlation of mean depth to fish production in large lake systems. Similarly, high plankton densities in the side bays also suggested good water quality and nutrient levels.

Ashton Reservoir, however, has an exceedingly short retention time of 1.6 to 4.5 days. This is by far the greatest limiting factor to the development of dense plankton populations. The swift currents, 17 to 36 m/minute in the upper section of the reservoir, precluded most plankton development. During August, surface currents in the reservoir midsection were wind-driven and much slower (1 to 3 m/minute). This indicated that the inflow of river current was passing through the reservoir at a deeper depth. River water entering the reservoir was 14 C and thus substantially denser than the 17 C water in the center of the reservoir (Appendix B). Surface water, therefore, was possibly isolated from the more rapidly flowing deeper water and thus gave plankton at least a limited opportunity to develop in the upper water layer. This finding may explain the limited increase in plankton density in August.

During winter, aquatic vegetation dies, insect activity diminishes, small young-of-year fish are fewer and larger and less terrestrial insects would be expected to enter the reservoir. At this time of year, plankton may become increasingly important. Winter zooplankton densities below 1 organism/liter are insufficient for trout forage. Return of fingerling rainbow trout to the creel in Flaming Gorge Reservoir declined as zooplankton density dropped from 186 to 64 organisms/liter (Schneidervin and Hubert 1985). Zooplankton density in Ashton Reservoir peaked at only 6.6 organisms/liter and thus could be responsible for the low overwinter survival of both catchable-size and fingerling trout. Based on creel survey results and gill net catches of fingerling and catchable-size trout, overwinter mortality of hatchery trout in Ashton Reservoir was in excess of 99%.

In Magic Reservoir, Idaho, rainbow trout avoided water of 20.3 C (Reininger 1984). Surface temperatures in excess of 20 C at the lower end of Ashton Reservoir in midsummer would also have been too warm for rainbow and cutthroat trout. These trout could have found suitable habitat by moving deeper or by moving toward inflow streams where the temperature was more favorable. The deepest sections of the reservoir contained less than 5 mg/liter of oxygen during June 1985 and thus may also have been avoided. Trout could have avoided this area by moving shallower. Van Velson (1986) documented summer kills of trout in Pueblo Reservoir, Colorado, only after water warmed above 21 C or dissolved oxygen was below 3.0 mg/liter. Trout apparently stayed in areas of suitable habitat until all of it was lost. Conditions in Ashton Reservoir were not this severe and thus temperature and oxygen were not responsible for the poor trout numbers in the reservoir.

Creel Survey

Fishery goals for Ashton Reservoir were a catch rate of 1 fish/hr and fish averaging 25 to 30 cm. These goals were set to make the Ashton Reservoir fishery comparable to the Henrys Fork above and below the reservoir (Rohrer 1981). Annual stocking of catchable-size trout would seem to be the best strategy due to the poor overwinter survival of hatchery fish. The stocking of 12,745 catchable-size trout and 78,905 fingerlings in 1985 increased catch rate to 0.93 fish/hr for a single two-week interval, but the average for the year was 0.65 fish/hr. The increased stocking rate of 27,000 catchable-size trout, plus 60,000 fingerlings, during 1986 increased catch rate to 0.95 fish/hr--near our goal of 1 fish/hr.

In the future, fingerling stocking should be discontinued; therefore, catch rate will be adjusted solely by catchable-size fish. In order to have a 1 fish/hr catch rate, 15,307 fish would need to be caught. (There were 15,307 hours of pressure during 1986). Also included in the 1986 harvest were 2,233 wild fish (mean size = 278 mm) and 2,856 fish that were released as being too small (estimated mean size = 152 mm). This segment of the fishery should remain stable. Based on a 35% return rate, 29,194 catchable-size trout would need to be stocked to bring the total catch to 15,307 fish. The following number-weighted size equation:

$$2{,}233 \text{ fish} \times 278 \text{ mm} + 2{,}856 \text{ fish} \times 152 \text{ mm} + 10{,}218 \text{ fish} \times Y \text{ mm} = 15{,}307 \text{ fish} \times 279 \text{ mm}$$

was solved for Y to determine the mean size of stocked trout that will result in an average size at harvest of 279 mm. Thus, the mean size of fish to stock equals 315 mm. Ten percent of the hatchery fish should be stocked in March, 40% in June, 30% in July and 20% in August to keep the catch rate near our goal and provide the best return. No trout should be stocked during runoff because fishing pressure is low and poor returns would be expected. Also, no winter stocking is necessary because catch rate during this season greatly exceeded our goal. High winter catch rate will likely continue as long as kokanee emigration from Island Park Reservoir continues.

Ashton Reservoir was rated by fishermen as the poorest stretch of the Henrys Fork during 1980: 61% rated it as poor, 32% rated it fair, 2% rated it good and 0% rated it excellent (Rohrer 1981). After our stocking program in 1985 and 1986, the anglers, perception of the fishery improved considerably: 29% rated it as poor, 34% fair, 26% good and 7% excellent (Table 3). It has not, however, reached the high ratings anglers gave for upstream and downstream sections of the Henrys Fork (Rohrer 1981). Idaho anglers tend to value river fishing more than lake fishing. Net willingness to pay for a fishing trip on the Henrys Fork ($42.25/trip) was worth 23% more than fishing trips on Blackfoot Reservoir ($33.12) or American Falls Reservoir ($35.49) (Sorg et al. 1985). Anglers also place a premium value on a wild trout fishery over a stocked trout fishery, again based on willingness to pay, by a ratio of 1.8 to 1.0 (Marshall 1973). Thus, angler approval on the reservoir may never be comparable to the adjacent river sections. Fishermen who thought the fishing was poor most frequently believed this was due to a poor abundance of fish (even more so than size and abundance) and so additional stocking may improve their perceptions.

Coon (1977) measured fishing pressure on Ashton Reservoir from January 1 to August 31, 1973 and 1976 at 7,067 and 5,303 hours, respectively. Rohrer (1981) estimated 5,128 angler hours from March 1, 1980 to February 28, 1981. Pressure had increased to 12,631 hours during 1985 and 15,307 hours during 1986. Although the sampling period during the 1970s was less than one year, it appears that pressure on Ashton Reservoir has doubled in the last 10 years. Trout stocking and the subsequent increase in catch rate undoubtedly attracted additional fishermen.

Fishing pressure on the Henrys Fork above Ashton Reservoir also more than doubled in the last five years without additional stocking (5,128 hours in 1980-1981 to 10,437 hours in 1985-1986, for a six-month fishing season). Thus, more leisure time, lower gasoline prices and increased popularity of drift boating all may have contributed to a general increase in the amount of fishing throughout this region. The Henrys Fork River from Chester Dam to Fritz Bridge (5.8 km) provided 2,406 hours of fishing effort/km during 1980--the closest reach to Ashton Reservoir with a year-round fishing season. This compares to 2,265 hours/km on Ashton Reservoir. It appears that the stocking program of 1986 successfully increased pressure to a level similar to the river.

Trout Strain Evaluation

Ashton Reservoir is somewhat different from other ponds and reservoirs where strain evaluations have been conducted because it is a more "open" system, with a large inflow and outflow (the Henrys Fork). Any trout that widely disperse from the point of stocking will not benefit the reservoir fishery. Fish that move from the reservoir to the river may contribute to the river fishery; however, the river already supports catch rates from 1 to 1.5 fish/hr with its wild trout populations. Return rates of hatchery trout stocked into the river below Ashton Dam averaged 18% and above Ashton Reservoir averaged 25% (Coon 1977). Thus, trout that leave the reservoir had a limited benefit to an already good river fishery.

Behnke (1979) cited numerous studies where wild trout survival was better than hatchery trout survival in natural waters and the physiological basis for these differences. Ashton Reservoir has existed for 61 years and has not yet developed an abundant wild trout population (Table 5), perhaps because of low winter plankton production (Fig. 6). Stocking wilder trout strains that are more difficult and expensive to rear would not be advisable due to this lack of sufficient year-round habitat. Stocking salvaged wild trout from the Henrys Lake outlet met with good angler acceptance due to their large size. However, they had the lowest return rate of any strain stocked because they were in spawning condition and left the reservoir shortly after stocking. Also, these trout would not be available for stocking during the summer.

Partridge (1985) was the first to evaluate Hayspur rainbow trout performance in Magic Reservoir. One year after being stocked as fingerlings, they had the highest return by bank anglers of any strain tested and the second highest return by boat anglers. In Ashton Reservoir, this trout strain exhibited better return rates than other trout strains in two out of three comparative evaluations (Figs. 10 to 12). The one test in which they did not perform well was conducted during the summer of 1986 (Fig. 11). Even during this test, they had the best performance for the first four weeks. After the fourth week, a second group of 2,000 of each strain were stocked. It was after this stocking that Hayspur trout did not outperform other strains, which suggests that problems occurred with this group of fish. Possibly they were less aggressive feeders, or encountered problems while being transported.

Hayspur fish were also preferred because they had a higher harvest rate by bank anglers (Table 4). This was a desirable attribute because bank anglers were generally less effective than boat anglers and comprised 69% of the fishing effort. Hayspur trout should be the first choice of fish to stock. They are especially preferable to finespot cutthroat trout or generic rainbow trout and could reduce the number of fish needed by 50%. Desirable attributes of the Hayspur trout were their immediate vulnerability after stocking and an apparent low dispersion rate. Finespot cutthroat behaved differently. They had a more gradual return over time and quickly moved from the point of stocking. Both factors likely contributed to their overall low returns.

Generic trout (Mt. Lassen strain) gave variable results. They performed well during the summer of 1986 with a 46% return rate, but did less well during the two other tests, with return rates of 25% and 13%. Variability may have been due to differences in the quality of the eggs. Eggs from older or later maturing fish may be of lower quality and thus are sold by hatcheries at a lower price. Eggs bought for this study could have been from a variety of lots, thus resulting in variable results. A logical extension of this study would be to test this hypothesis and other variations within strains, such as pond versus raceway rearing.

Fish Sampling

Utah chubs and Utah suckers comprised 98% of the fish sampled during 1985 and 94% during 1986. These species were well adapted to the reservoir habitat, perhaps due to their ability to adjust to existing food sources. Utah chubs are known to prefer larger plankters, but in Ashton Reservoir they consumed mostly algae (Schneidervin and Hubert 1985). Total eradication of these species would be impossible because of the large drainage and due to their prolific nature, they would return in several years. Low reservoir plankton density was likely due to the short retention time and plankton densities would not be expected to increase significantly even with total eradication of nongame species. The attempt to control nongame fish is therefore not advised.

A better approach would be to utilize Utah chubs as a forage base for larger trout. Numerous Utah chubs under 25 cm were collected in gill nets and represent a large potential forage base (Fig. 13). Brown trout have been stocked into the Henrys Fork above Ashton Reservoir (approximately 50,000 fingerlings annually). As these trout grew, some apparently moved into the reservoir and capitalized on the forage base. Brown trout up to 60 cm have been harvested and provide an occasional trophy; however, they made up only 1.5% of the total annual harvest (Fig. 14). If the brown trout population increases, they may contribute more to the fishery. However, brown trout are not as vulnerable to angling as other species (Behnke 1979) and therefore, rainbow trout stocking will be needed to maintain our catch rate goal.

Diet Analysis

Ersbak and Haase (1983) documented nutritional deprivation as a possible reason for declines of stocked brook trout. Stomach contents of trout strains stocked in Ashton Reservoir were examined to determine if a similar problem was occurring in Ashton Reservoir. Examination of stomach samples began several weeks after stocking in order to document diet before maladapted trout starved. No obvious differences in diet were observed between hatchery trout strains and wild trout. Nearly all trout were feeding on insects and had food material in their stomachs. It, therefore, did not appear that limited food availability was responsible for summer declines in trout abundance. This finding was consistent with the good growth rates observed for fingerling trout throughout the summer. Starvation, however, was suspected as an important factor in low overwinter survival, but this was not documented by our diet study.

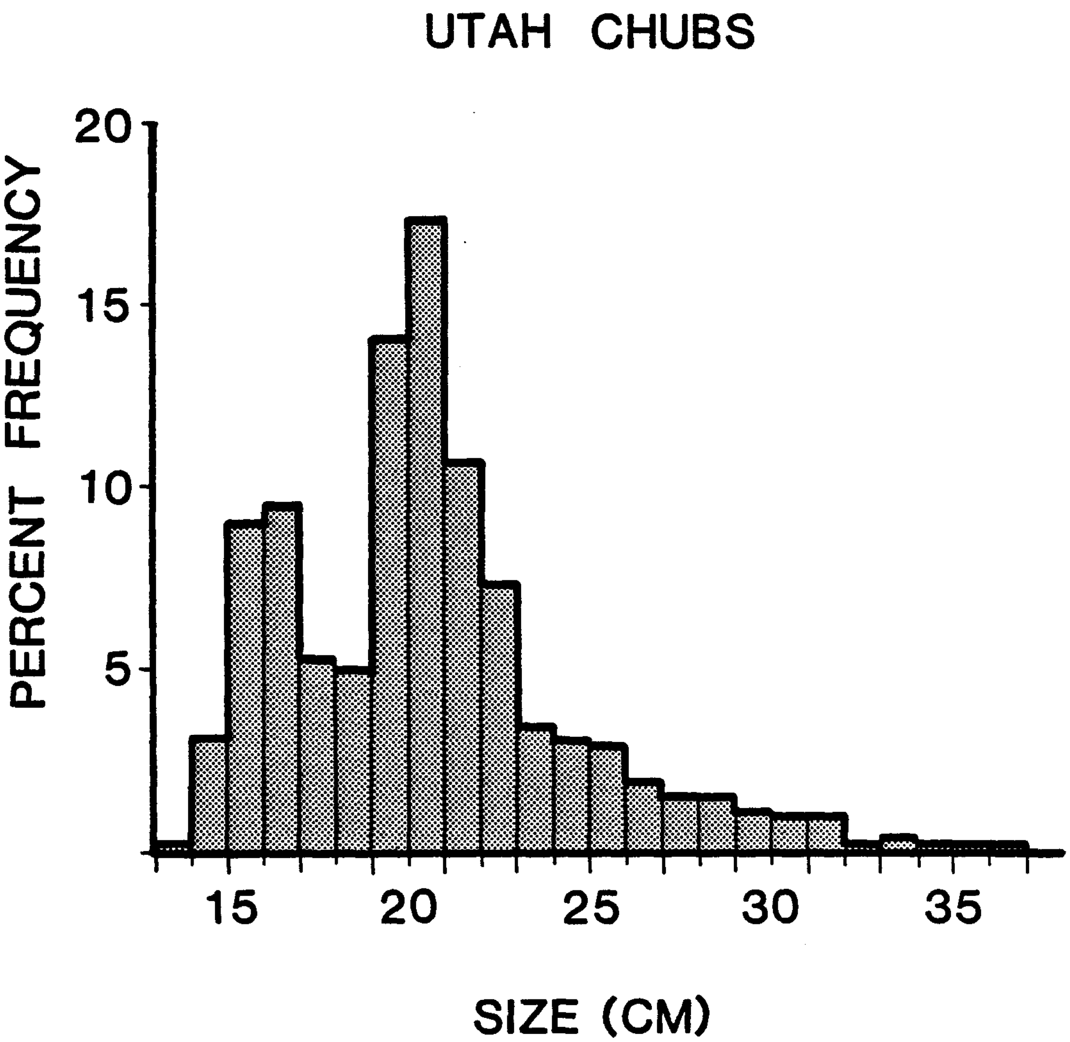

Figure 13. Size-frequency distribution of Utah chubs collected by monofilament gill nets in Ashton Reservoir, 1986.

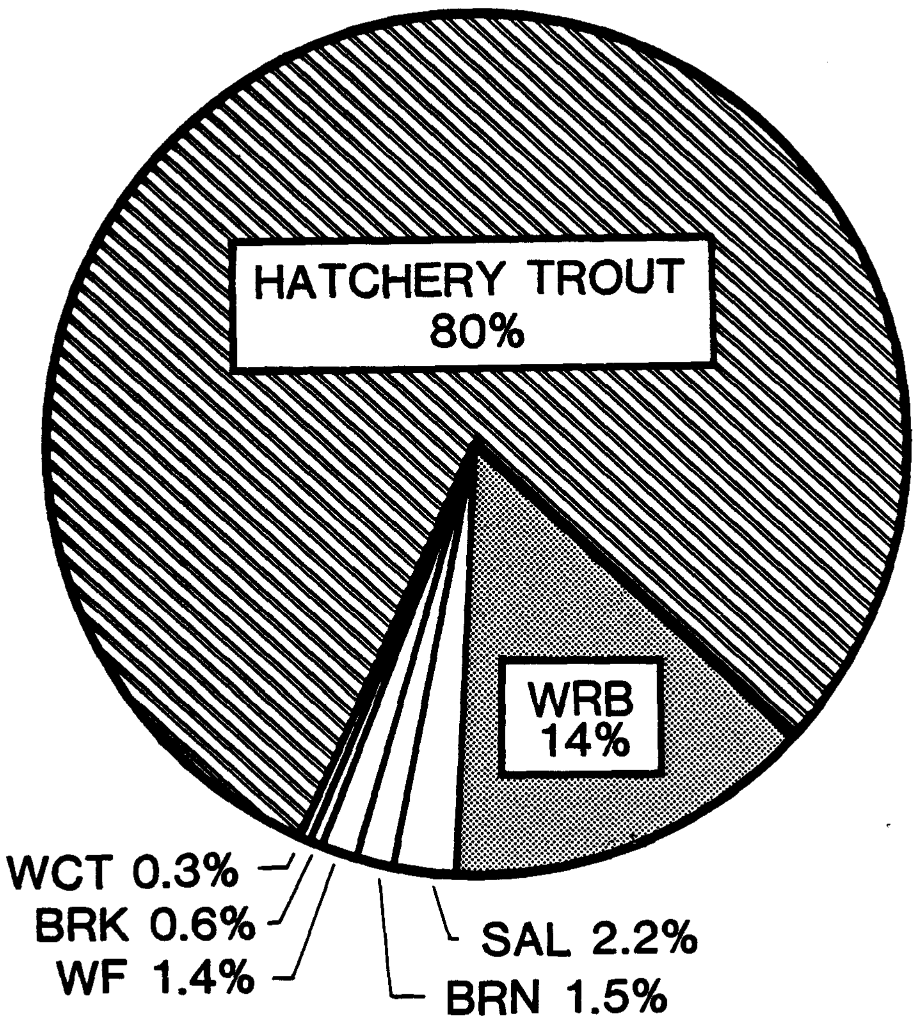

Figure 14. Angler harvest of all species from Ashton Reservoir, 1986. WRB = wild rainbow trout, SAL = salmon, BRN = brown trout, WF = whitefish, BRK = brook trout and WCT = wild cutthroat trout.

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APPENDICES

Appendix A. Origins and histories of trout strains used in Ashton Reservoir enhancement study.

Bear Lake Cutthroat Trout

Eggs of Bear Lake cutthroat trout (Salmo clarki utah) were collected annually by Utah Division of Wildlife Resources personnel from Swan Creek, a tributary to Bear Lake. These eggs became brood fish at the J. Perry Egan Hatchery, Bicknell, Utah, where they were kept one generation before being replaced by fish spawn from wild stock. Eyed eggs from the Egan Hatchery brood fish were sent to the Grace Hatchery, Grace, Idaho, where they were reared to fingerling size and then transported to Ashton Reservoir.

Bear Lake cutthroat evolved in association with fish fauna of Bear Lake (Behnke 1979). They are a highly piscivorous cutthroat, which at a length of 250 mm begin to feed on fish and by 45 to 50 cm feed exclusively on fish (Nielson and Archer 1977).

Mt. Shasta Strain

The Hot Creek strain of rainbow trout (formerly a McCloud strain from Springville, Utah) was crossed with brood stock from Meader's Trout Farm, Pocatello, Idaho, to produce the Mt. Shasta strain in 1950-1952 (Partridge 1985; Busack and Gall 1980). Original brood stock were kept at the State Fish Hatchery, Mt. Shasta, California. Eggs from these fish were used to start a second brood stock at the Ennis National Fish Hatchery, Ennis, Montana, during February 1981 and March 1982.

No outside strains have been added to this brood stock since then. Ennis brood fish were originally selected for high egg survival, but were later chosen randomly from eggs collected at the peak of spawn (Wess Orr, Ennis National Fish Hatchery, personal communication). Eggs from Ennis were reared to fingerling size at the Mackay State fish Hatchery, Mackay, Idaho, in concrete raceways.

Overall, the Mt. Shasta strain had the highest return rate of the four strains tested at Magic Reservoir and had particularly good returns among boat anglers (Partridge 1985). This strain performed well when compared to Whitney and Virginia strains (Cordone and Nicola 1970), but was outperformed by Coleman Kamloops in California reservoirs (Rawstron 1972, 1977).

Appendix A, continued.

Sand Creek Strain

Sand Creek rainbow trout were reared at the Grace Hatchery, Grace, Idaho. Fish were fed 100% pelleted diet and reared in raceways. Certified disease-free eggs originated from the J. Perry Egan Hatchery, Bicknell, Utah. The Sand Creek strain brood stock have been at the Egan Hatchery since 1971 with no outside introductions to the brood stock.

Original brood fish came to this hatchery during March 1971 from the Fish Genetics Lab at Beulah, Montana. These trout spawn from September to November and are selected for their ability to produce eggs of good quality and large numbers (Blaine Hilton, Egan Hatchery Superintendent, personal communication).

Performance of the Sand Creek strain was evaluated by Hudy and Berry (1983) at Porcupine Reservoir, Utah. They concluded that the Sand Creek, Ten Sleep and Shepherd of the Hills strains had no significant differences in survival to the creel or in catchability. Therefore, the strain to stock should be based on hatchery criteria. Sand Creek trout, however, had one of the highest return rates (48%) of five strains tested in Virginia streams. Also, they were harvested more uniformly over time than several of the other strains (Fay and Pardue 1986).

Hayspur Strain

These rainbow trout were spawned and reared at the Hayspur State Fish Hatchery at Bellevue, Idaho. Partridge (1985) reported that the original broodstock resulted from a cross between the Hot Creek strain and a local rainbow trout, probably from Silver Creek, Blaine County, Idaho, around 1910. He also reported that other strains have been mixed with the brood stock, including Gerrad Kamloops in 1965; rainbow trout from Roaring River, Oregon, in 1983; and Hot Creek rainbow trout in 1983.

Hayspur trout spawn from October through December. Three groups of these fish were studied. The first two groups were raceway-reared on a 100% pelleted diet and the third was a pond-reared group that obtained a fraction of their diet from natural sources and was therefore studied separately.

Partridge (1985) was the first to evaluate this strain of trout. In his tests at Magic Reservoir, they had the highest return of the various strains harvested by boat anglers.

Henrys Lake Cutthroat Trout

Cutthroat trout from Henrys Lake may be descendants of the original wild stock, but the introduction of cutthroats from Yellowstone Lake, Wyoming, and Gold Creek, Idaho, may have added to the gene pool. Also, rainbow trout and hybrids of rainbow X cutthroat trout have been stocked in Henrys Lake (Irving 1954).

The Henrys Lake Fish Hatchery, located on Hatchery Creek adjacent to the lake, uses a run of cutthroat from the lake as brood fish. Fry from these fish are then released back into the lake. Wallace and Rourke (1978) studied these cutthroats by morphological examination and electrophoresis. They concluded that there were very few "true hybrid" trout in the spawning run to the hatchery in 1976. Currently, hatchery personnel chose returning spawners at random to avoid selection (Lynn Watson, Henrys Lake Hatchery Superintendent, personal communication).

During the spring spawning run, large numbers of cutthroat trout pass over the Henrys Lake outlet. Fish used in our study were collected by seining the stream below Henrys Lake Dam.

Finespot Cutthroat

Finespot cutthroat broodstock were originally collected as eggs from Flat Creek, Jackson, Wyoming, in 1953. Fish were gradually shifted to fall spawners (late October to mid-January) by selecting the earliest running fish as replacement stock at Wyoming's Auburn Fish Hatchery, Auburn, Idaho (Ralph Bonner, Superintendent, Auburn Hatchery, personal communication). Brood stock from the Auburn Hatchery were transferred to the Jackson National Fish Hatchery, Jackson, Wyoming. Both males and females of this strain mature in three years. Our test fish were spawned and reared at the Jackson Hatchery. They were kept in cement raceways and fed entirely on a pelleted diet.

A trout strain evaluation study was conducted in two ponds near Three Forks, Montana (William P. Dwyer, Fish Technology Center, Bozeman, Montana, unpublished data). Finespot cutthroat from the Auburn Hatchery had the highest rate of return (52%) and provided the highest catch rate in this comparative evaluation with Colorado River cutthroat and the McBride Lake strain of Yellowstone cutthroat. Thus, finespot cutthroat appeared to be more vulnerable to angling pressure.

Appendix A, continued.

Mt. Lassen and Generic Rainbow Trout

The designation "generic rainbow trout" was used to describe trout of unspecified origin when these eggs were ordered. Eggs were therefore bought by the state on a low bid process. All generic trout used in this study were actually of the Mt. Lassen strain. Throughout the study, generic trout were kept separate from the Mt. Lassen strain to determine if differences existed. Generic eggs were raised to catchable-size at the Ashton Fish Hatchery, Ashton, Idaho. Mt. Lassen trout eggs were reared to a catchable-size at the Mackay Hatchery, Mackay, Idaho.

The Mt. Lassen strain of rainbow trout eggs were obtained from Mt. Lassen Trout Farm, Red Bluff, California. This strain has been domesticated for 20 years and originated from crosses between Canadian Kamloops and Mt. Shasta rainbow trout (Reininger 1984). In Magic Reservoir, Mt. Lassen rainbow trout outperformed Mt. Whitney rainbow trout, but the difference may have been due to the smaller size of the Mt. Whitney fingerlings (Reininger 1984; Partridge 1985).

Kamloops Rainbow Trout

Brood fish of this strain originated in Canada in 1944 (Ed McClearly, Trout Lodge Hatchery, Washington, personal communication), possibly from Kootenai Lake, British Columbia, Canada (Collin Skane, Skane Fish Farm, personal communication). They served as brood stock at Trout Lodge Hatchery, Tacoma, Washington, and were used to start the brood fish at the Skane Fish Hatchery, Moses Lake, Washington, during 1973. Skane Fish Farm brood stock have been selected for color, size and egg number, with no known introductions of other strains. Eggs from the Skane Fish Farm were shipped to the Ashton Fish Hatchery where they were reared to fingerling size before stocking into Ashton Reservoir.

Fingerlings of this strain were evaluated in Magic Reservoir, Idaho. Return to creel of these fingerlings was the lowest, providing a catch rate of 0.001 fish/hr to both boat and bank anglers during 1983 (Reininger 1984). The following year (1984), return of Kamloops was significantly less than the other two strains stocked in 1983 (Partridge 1985).

Appendix B. Limnological survey results collected within Ashton Reservoir, Idaho, 1986. Station 1 is above Ashton Dam, Station 2 is located at mid-reservoir and Station 3 is located on the upper section of the reservoir.

	Temperature			Dissolved oxygen			Conductivity			Secchi depth		
Station	1	2	3	1	2	3	1	2	3	1	2	
Depth (m)												
3/2/86												
Surface	6.0	6.0	5.3	9.9	9.5	10.6	70	69	68			
1	6.0	5.6	5.3	9.9	9.5	10.6	70	70	68			
2	6.0	5.4	5.3	9.9	9.5	10.6	71	70	68			
3	5.9	5.2		9.9	9.4		71	71				3.0
4	5.8	5.2		9.9	9.4		71	71			4.0	
5	5.8	5.2		9.9	9.4		71	71		4.2		
6	5.8	5.2		9.9	9.4		71	72				
7	5.7	5.2		9.9	9.4		72	72				
8	5.7	5.2		9.9	9.2		72	72				
9	5.6			9.9			72					
10	5.6			9.9			72					
11	5.5			9.8			72					
12	5.2			9.8			72					
13	5.1			9.6			78					
4/16/86												
Surface	7.5	7.5	7.0	9.7	9.0	9.5	59	55	48			
1	7.8	7.8	7.0	9.7	8.9	9.5	59	58	50	1.4	1.4	1.2
2	7.8	7.9	7.0	9.8	8.8	9.5	59	58	50			
3	7.8	7.8		9.8	8.8		59	58				
4	7.5	7.8		9.8	8.8		59	58				
5	7.5	7.8		9.8	8.8		60	59				
6	7.5	7.6		9.7	8.8		60	59				
7	7.5	7.5		9.7	8.7		60	59				
8	7.5			9.7			60					
9	7.5			9.7			60					
10	7.5			9.7			60					
11	7.4			9.7			60					
12	7.2			9.7			60					
13	7.2			9.7			60					
14	7.0			9.7			60					

Appendix B, continued.

Station	Temperature 1	2	3	Dissolved oxygen 1	2	3	Conductivity 1	2	3	Secchi depth 1	2	3
Depth (m)												
5/16/86												
Surface	10.0	9.0	8.0	9.4	8.8	9.8	58	53	48			
1	9.5	8.8	8.0	9.4	8.8	9.8	58	55	49	1.9	1.6	2.0
2	9.3	8.5	8.0	9.4	8.8	9.8	58	55	50			
3	9.2	8.3		9.4	8.8		59	58				
4	9.2	8.2		9.4	8.7		59	58				
5	9.2	8.2		9.4	8.6		59	58				
6	9.1	8.2		9.4	8.7		59	58				
7	9.1	8.2		9.4	8.8		59	58				
8	9.1	8.2		9.4	8.6		59	75				
9	9.1			9.4			60					
10	9.1			9.5			60					
11	9.1			9.6			60					
12	9.1			9.6			61					
13	9.1			9.6			61					
14	9.1			9.6			61					
14.5	9.0			9.6			65					
6/19/86												
Surface	17.2	17.0	14.6	8.3	8.3	9.1	85	80	72			
1	17.2	17.0	14.8	8.3	8.2	9.1	85	80	72	2.0	2.5	2.0
2	17.2	17.0	14.8	8.4	8.2	9.1	86	82	74			
3	17.1	16.0	14.8	8.4	7.8	9.1	87	82	75			
4	17.0	15.8		8.3	7.7		88	81				
5	16.8	15.2		8.1	7.5		85	80				
6	16.4	15.1		8.0	7.4		86	80				
7	16.2	15.1		8.0	7.3		87	80				
8	16.0	15.0		7.8	7.2		86	95				
9	16.0			7.7			87					
10	16.0			7.7			88					
11	15.9			7.6			88					
12	15.9			7.5			88					
13	15.9			7.4			88					
13.7	15.5			7.4			105					

Appendix B, continued.

Station	Temperature 1	2	3	Dissolved oxygen 1	2	3	Conductivity 1	2	3	Secchi depth 1	2	3
Depth (m)												
7/14/86												
Surface	17.3	16.8	15.6	8.7	7.7	8.7	103	90	83			
1	17.0	16.8	15.5	8.7	7.7	8.7	103	92	85			
2	17.0	16.5	15.2	8.7	7.8	8.7	102	92	88			2.2
3	16.9	16.1		8.7	7.6		101	92		3.5	3.2	
4	16.9	16.0		8.8	7.4		101	92				
5	16.9	16.0		8.6	7.4		100	92				
6	16.8	15.9		8.6	7.2		100	93				
7	16.8	15.9		8.6	7.3		100	93				
8	16.8	15.8		8.6	7.2		100	93				
9	16.6			8.5			100					
10	16.6			8.5			100					
11	16.4			8.3			100					
12	16.0			8.0			99					
13	15.5			7.4			99					
13.5	15.5			6.6			123					
8/13/86												
Surface	17.4	16.6	14.5	7.2	7.0	9.1	101	99	85			
1	16.9	16.4	14.2	7.2	7.0	8.1	101	99	88			
2	16.8	16.0	14.2	7.2	6.9	8.1	101	99	88			
3	16.8	15.7	14.4	7.2	6.9	7.9	101	98	88			2.6
4	16.8	15.4		7.2	6.4		101	97		3.7	3.8	
5	16.7	15.0		7.2	6.2		101	96				
6	16.7	14.9		7.2	6.2		101	96				
7	16.7	15.0		7.2	3.0		102	98				
8	16.7			7.2			102					
9	16.6			7.2			103					
10	16.5			7.2			103					
11	16.5			7.2			103					
12	16.5			7.2			103					
13	16.5			7.2			104					
14	16.5			6.3			119					

Appendix B, continued.

	Temperature			Dissolved oxygen			Conductivity			Secchi depth		
Station	1	2	3	1	2	3	1	2	3		2	
Depth (m)												
9/16/86												
Surface	13.0	13.0	11.0	8.4	8.6	9.8	79	75	70			
1	13.0	12.9	11.0	8.4	8.6	9.8	79	75	70			
2	12.9	12.7	11.0	8.4	8.4	9.8	79	78	70			
3	12.9	12.5		8.5	8.3		79	78		3.4		
4	12.8	12.0		8.5	8.0		79	78			4.1	
5	12.8	11.9		7.5	7.7		80	78				
6	12.5	11.8		8.5	7.6		80	78				
7	12.5	11.4		8.5	7.5		80	78				
8	12.5	11.3		8.5	7.4		80	79				
9	12.2			8.0			81					
10	12.0			7.8			81					
11	11.9			7.7			81					
12	11.8			7.7			88					
12.1	11.7			7.3								
10/14/86												
Surface	6.1	6.8	5.8	9.4	9.6	10.6	68	68	64			
1	6.0	6.5	5.8	9.5	9.6	10.8	68	68	64			
2	5.7	6.1	5.8	9.5	9.2	10.6	68	68	64			
3	5.5	6.0		9.4	9.1		68	68				
4	5.5	5.9		9.4	8.9		69	68				
5	5.5	5.8		9.4	8.8		69	69		4.8	4.2	-
6	5.5	5.8		9.4	8.8		69	69				
7	5.5	5.8		9.4	8.8		69	70				
8	5.5			9.4			69					
9	5.5			9.4			70					
10	5.5			9.4			70					
11	5.5			9.4			70					
12	5.5			9.4			70					

Appendix B, continued.

Station 1	Temperature Nov 86	Dec 86	Jan 86	Dissolved oxygen Nov 86	Dec 86	Jan 86	Conductivity Nov 86	Dec 86	Jan 86	Secchi depth Nov 86	Dec 86	Jan 86
Depth (m)												
Surface	2.0	0.5	0.0	10.6	11.2	10.8	60	73	75			
1	2.0	0.5	0.5	10.6	11.6	10.7	61	72	78			
2	2.0	0.5	0.5	10.6	11.6	10.6	61	72	78			2.2
3	2.0	0.6	0.5	10.6	11.4	10.6	62	73	78	3.8		
4	2.0	1.0	0.5	10.8	11.2	10.8	62	75	78		4.6	
5	2.0	1.0	0.5	10.8	11.1	10.7	63	75	78			
6	2.0	1.0	0.5	10.8	11.1	10.5	63	78	79			
7	2.0	1.0	0.5	10.8	11.1	10.8	64	79	79			
8	2.0	1.1	0.5	10.8	11.1	10.8	65	79	79			
9	2.0	1.1	0.5	10.8	11.1	10.8	65	79	80			
10	2.0	1.1	0.5	10.8	11.1	10.8	66	79	80			
11	2.0	1.1	0.5	10.8	11.2	10.8	66	79	81			
12	2.1	1.4	0.5	10.8	11.2	10.8	67	80	81			
13	2.1	1.5	0.5	10.8	11.4	10.8	68	80	81			
14	2.1	1.5	0.5	10.6	3.8	4.5	68	82	83			

Appendix C. Zooplankton densities at various locations in Ashton Reservoir. Station 1 = lower reservoir and Station 2 = mid-reservoir.

Date	Station 1	Station 2	Cedar Gulch	Rattlesnake Bay	Willow Creek Bay
4/26/86	0.22	0.000			
5/16/86	0.066	0.017			
6/19/86	0.575	2.724			
7/14/86	0.886	0.462	23.343	115.810	164.755
8/13/86	6.619	1.651	152.350	168.883	201.383
9/16/86	1.814	1.065	12.188	55.839	73.798
10/14/86	0.279	0.422	0.941	2.929	1.632
11/14 to 28/86	0.036	0.020			
12/21/86	0.024				
1/14/87	0.069				

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Appendix D. Fishing pressure in hours/two-week interval by reservoir section and boat, bank and ice anglers on Ashton Reservoir, Idaho, 1986. Section 1 = lower reservoir, Section 2 = mid-reservoir, Section 3A = upper end of reservoir above county boat ramp and Section 3B = upper end of reservoir below county boat ramp.

Interval number	Total hrs.	Section 1	Section 2	Section 3A	Section 3B	Angler type Ice	Angler type Boat	Angler type Bank
18	104	104	0	0	0	104	0	0
19	77	58	0	19	0	58	0	19
20	148	87	0	61	0	87	0	61
21	305	0	0	47	258	0	0	305
22	449	15	23	201	210	0	55	394
23	530	132	25	217	156	0	469	61
24	650	87	107	126	330	0	236	414
25	170	14	14	71	71	0	27	143
26	109	18	0	14	77	0	0	109
27	362	0	72	246	44	0	87	275
28	872	199	110	218	345	0	102	770
29[a]	161	15	0	38	108	0	38	123
30	1,377	123	181	255	818	0	482	895
31	1,721	90	335	395	901	0	521	1,200
32	1,958	158	416	446	938	0	672	1,286
33	1,304	87	367	421	429	0	625	679
34	1,894	182	234	569	909	0	426	1468
35	879	138	87	244	410	0	113	766
36	300	101	38	117	44	0	6	294
37	242	24	18	128	72	0	66	176
38	186	28	56	40	62	0	132	54
39	405	26	106	101	172	0	127	278
40	238	41	44	49	104	0	117	121
41	435	10	354	0	71		355	80
42	14	5	0	0	9		0	14
43	88	30	0	0	58	30	58	0
44	245	227	0	0	18	227	0	18
Totals	15,223	2,000	2,587	4,023	6,614	506	4,714	10,003

[a]cne-week interval.

Appendix E. Estimated numbers of trout harvested after stocking in Ashton Reservoir, 1985.

Weeks since stocking	Hayspur rainbow trout	Sand Creek rainbow trout	Generic rainbow trout	Finespot cutthroat trout	Henrys Lake cutthroat trout
2	173	62	5	96	47
4	526	498	173	237	72
6	552	281	159	60	87
8	106	207	55	72	43
10	89	74	53	21	0
12	12	115	23	4	0
14	42	6	0	0	0
16	32	17	6	8	0
18	6	32	0	0	0
20	0	0	0	0	0
22	3	0	0	4	0
24	0	0	0	11	0
26	0	0	0	23	0
28	0	0	0	0	0
30	0	0	4	6	0
32	3	0	8	9	0
34	0	3	34	7	0
36	5	0	12	23	0
38	0	0	0	16	0
40	0	0	0	5	0
42	19	0	0	2	0
44	8	0	0	4	0
46	0	0	0	0	0
48	0	0	0	0	0
50	0	0	0	4	0
52 to 58	0	0	0	0	0
Percent return	53	41	25	20	17

Appendix F. Percent return and Friedman Two-Way Analysis by ranks (R) for each of four strains of trout stocked into Ashton Reservoir during 1985. Rank 1 = lowest percent return and Rank 4 = highest percent return (Elliot 1983).

Weeks since stocking	Hayspur rainbow		Sand Creek rainbow		Generic rainbow		Finespot cutthroat	
		R	%	R	%	R		R
2	5.8	4	2.0	2	0.2	1	4.6	3
4	17.5	4	15.8	3	8.2	1	11.3	2
6	18.4	4	8.9	3	7.6	2	2.9	1
8	3.5	3	6.6	4	2.6	1	3.4	2
10	3.0	4	2.3	2	2.5	3	1.0	1
12	0.4	2	3.7	4	1.1	3	0.2	1
14	1.4	4	0.2	3	0	1.5	0	1.5
16	1.1	4	0.5	3	0.3	1	0.4	2
18	0.2	3	1.0	4	0	1.5	0	1.5
Totals		32		28		15		15

$\Sigma R4 = 90$

$\Sigma(R_4)^2 = 2{,}258$

$n = 4$

$i = 9$

$S = 233$

$X^2 = 15.533$

Table X^2 value for $v = 3$ and 99% confidence = 11.34

Result: reject H_o (that all strains had similar return rates) at the $P < 0.01$ level of significance.

Appendix G. Harvest of four strains of trout stocked into Ashton Reservoir, Idaho, 1986.

Weeks since stocking	Finespot cutthroat number harvested	Hayspur rainbow number harvested	Mt. Lassen number harvested	Generic number harveste
2	34	444	275	317
4	155	518	337	454
6	258	291	398	619
8	163	102	146	240
10	179	185	185	198
12	48	64	105	44
14	29	29	82	12
16	12	8	31	39
18	4	8	27	27
20	7	7	49	49
22	0	55	37	164
24	0	35	52	52
26	3	0	0	14
28	0	16	16	32
30	15	22	44	44
Totals	907	1,784	1,784	2,305
Percents	18%	36%	36%	46%

Appendix H. Friedman Two-Way Analysis by ranks (R) for each of four strains of trout stocked into Ashton Reservoir during 1986. Rank 1 = lowest percent return and Rank 4 = highest percent return (Elliot 1983).

Weeks since stocking	Hayspur rainbow	Generic rainbow	Mt. Lassen rainbow	Finespot cutthroat
2	4	3	2	1
4	4	3	2	1
6	2	4	3	1
8	1	4	2	3
10	2.5	4	2.5	1
12	3	1	4	2.5
14	2.5	1	4	2.5
16	1	4	3	2
18	2	3.5	3.5	1
Totals	22	27.5	26	14.5

E R_4^2 = 2,126.5
E R4 = 90
S = 101.5
X^2 = 6.767
Table X^2 value for v = 3 and 90% confidence = 6.25
Result: reject Ho (that all strains had similar return rates) at the P <.10 level of significance.

Appendix I. Harvest of pond-reared Hayspur rainbow trout and generic rainbow trout stocked into Ashton Reservoir during August 1986. Sign test was used to compare numbers of trout returned (Steele and Torrie 1960).

Weeks after stocking	Hayspur rainbow	Generic rainbow	Sign test value Hayspur-Generic
2	593	161	+
4	89	64	+
6	47	18	+
8	8	11	-
10	8	4	+
12	42	21	+
14	37	18	+
16	70	0	+
18	2	2	+ = 7
20	0	8	- =1
22	0	7	
Percent return	36%	13%	

$$X^2 = \frac{(1|7 - 1|-1)^2}{7 - 1} = 25/6 = 4.167$$

d.f. = 1

Table X^2 = 3.84 at $P < 0.05$

Result: reject Ho that Hayspur rainbow trout and generic rainbow trout had similar return rates.

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